Federal Democratic Republic of Ethiopia

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ET 987 (2004) (English): Raw sugar - Specification

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ETHIOPIAN
STANDARD

ES 987:2004

(Reaffirmed: 2012)

First edition

Raw sugar - Specification

ICS: 67.180.10

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Foreword

This Ethiopian Standard has been prepared under the direction of the Technical Committee for Sugar and Sugar Products (TC 22) and published by the Ethiopian Standards Agency (ESA).

The standard is a reaffirmation for reprint of the Ethiopian Standard ES 987:2004, Raw sugar - Specification, with some editorial changes without altering the technical contents in the former text.

Raw sugar - Specification

1 Scope

This Ethiopian Standard specifies the requirements method of sampling and test for raw sugar

2 Normative references

The following Ethiopian Standards contain provisions, which through reference to this text constitute provisions of this Ethiopian Standard. At the time of publication the editions indicated were valid. All standards are subject to revision, and possibility of applying the most recent editions of the Ethiopian Standard indicated below. Registers of currently valid standards are maintained in the Ethiopian Standards Agency.

ES 359, *General standard for the labeling of pre-packaged food*.

ES 985, White sugar- specification;

ES 988, Determination of arsenic in food by silverdiethy dithio carbamate method.

ES 989, Determination of lead in food.

3 Definition

For the purpose of this Ethiopian Standard the following definition shall apply.

3.1
raw sugar
partially purified sucrose, which is crystallized from partially purified cane, juice without further purification but which does not preclude centrifugation or drying, and is characterized by sucrose crystals covered with a film of molasses.

4 Requirements

4.1 General

4.1.1 Raw sugar shall be free from dirty, extraneous matter, insect, rodent, fermented, musty or other undesirable odor.

4.1.2 Raw sugar shall be brown in color and shall have characteristic test of sucrose, and conform the requirements given in the following table.

4.1.3 Grain size, when raw sugar is tested in accordance with annex A not less than 95% of the material shall be retained on 500 micron sieve.

Table 1 — showing chemical requirements for raw sugar

No.	Characteristics	Requirements	Test methods
1 2	Polarization value, ^0Z Conductivity of ash % by mass max., Ash sulphated ash	96 - 99.5 0.20	ES 985 annex A Annex B
3	Reducing sugars, % by mass max.	1.0	ES 985 Annex C
4	Moisture content, % by mass max. (loss on drying)	0.30	ES 985 Annex B
5	Insoluble materials % by mass max.	0.06	Annex D
6	Color in ICUMSA units	800-1500	Annex C
7	Starch % by mass max.	0.20	Annex E
8	Dextran % by mass max.	0.03	Annex F

4.1.4 Raw cane sugar shall comply with the requirements of heavy metals limits given in the following table.

Table 2 — heavy metals requirements for raw sugar

No.	Characteristics	Requirements	Test methods
1	Arsenic (As) mg/kg max.	1.0	ES 988
2	Copper (Cu) mg/kg max.	2.0	ES 985 annex G
3	Lead (Pb) mg/kg max.	0.5	ES 989

4.2 Hygiene

4.2.1 Hygienic condition of raw sugar shall be done in accordance with ES 985 white sugar specification.

5 Packing and labeling

5.1 Packing

5.1.1 Raw sugar shall be packed in clean and sound materials that will afford it adequate protection during storage transportation distribution and use.

5.1.2 Each bag shall have a net mass of 50 kg or 100kg.

5.2 Labeling

5.2.1 Labeling of raw cane sugar shall be done in accordance with ES 359 general standard for the labeling of prepacked foods and shall include the following information.

i) Type of the product;

ii) Name and address of the manufacturer;

iii) Net mass of the product in kg;

iv) Date of packing;

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6 Storage

6.1 Storage of raw sugar shall be done in accordance with ES 985 white sugar specification.

7 Transportation

7.1 Transportation of raw sugar shall be done in accordance with ES 985 white -sugar specification.

8 Sampling

Sampling of raw sugar shall be done in accordance with ES 985 white sugar -specification.

Annex A
(normative)

A. Determination of particle size

A1 Apparatus

A1.1 Hot-air-oven

A1.2 Standard sieves- 500-micron or equivalent lid and receiver

A1.3 Sieve shaker

A.2 Reagent

A2.1 Anhydrous alcohol

A.3 Reagent

A3.1 Take 100gm of raw sugar, wash with 100ml of anhydrous alcohol, remove the excess alcohol by appropriate means.

A3.2 Dry the washed sugar in an air oven at 80^{0}C for one hour place the sieve on top of the receiver

A3.3 Transfer the dried sugar to 500micron sieve and sift the sugar by covering the lid in an automatic sieve shaker for 5 minutes.

A3.4 Weigh the sugar retained on the 500 micron sieve.

A3.5 Calculate the percentage of the sugar retained on 500 micron sieve.

$$\text{Percentage of Sugar retained} = \frac{M \times 100}{W}$$

Where

M mass of the sugar retained on 500 micron sieve;

W weight of the sample taken for the test.

Annex B
(normative)

B. Determination of conductivity ash

B1. Scope

The conductivity ash gives a measure of he concentration of ionized soluble salt present in samples having conductivities of up to 500 µs/cm at concentrations of up to 5g/100ml. The method is applicable to raw sugar, syrup and molasses.

B2. Principles

The specific conductivity of a sugar solution at a concentration of 5g/100ml less without the addition of sugar is determined. The equivalent ash is calculated by the application of a conventional factor.

B3. Apparatus

3.1 Conductivity meter

3.2 Volumetric flasks 100 and 1000ml

3.3 Analytical balance - readable to 0.1mg

B4. Reagents

4.1 Purified water with conductivity of less than 2 µs/cm.

4.2 Potassium chloride, 0.01 M Weigh out 745.5mg of potassium c hloride which has been dehydrated by heating to 500 ^{0}C (dull red heat), dissolve in water in a 1liter volumetric flask and make up to the mark.

4.3 Potassium chloride, 0.0025M dilute 250 ml of 0.01mol/L potassium chloride solution and make up to the mark in a 1 L volumetric flask. This solution has a conductivity of 328 µs//cm at 20 ^{0}C after deduction of the specific conductivity of the water used.

B5. Procedure

5.1 Prepare a solution by dissolving 5g of the sample in water in a 100 ml flask and make up to volume at 20^{0}C. In the event of the conductivity exceeding 500 µs/cm, reduce the solids content of the solution (for molasses use 0.25g/100ml.

5.2 Mix and transfer the solution to measuring cell and measure the conductivity at 20 ± 0.2 ^{0}C. Check the measurement by using the reference solution (4.3).

5.3 Calculation

If C_1 is the measured conductivity in µs/cm at 20^{0}C and

If C_2 is the specific conductivity of the water at 20^{0}C then the corrected conductivity (c) of the solution is

$$C = C_1 - C_2$$

Conductivity ash% = $(16.2 + 0.36D) \times 10^{-4} \times c \times f$

Where

D is the dry substance concentration of the solution tested in g/100ml;

S is the mass of sample in 100ml;

f is the dilution factor of the solution in comparison with 5g/100ml i.e. f=5/s.

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Annex C
(normative)

C.Determination of Raw Sugar Solution Color

C1 Scope

This method is used for the determination of raw sugar solution color. The method can be applied to raw sugars and affined raw sugars provided that a filtered test solution can be prepared by the procedure specified in the method. The method is designated for sugars in the solutioncolor range of 500 to 7000 IU.

C2 Principle

2.1 Raw sugar is dissolved in water, the solution is adjusted to $_{P}$H7 then filtered through a membrane filter to remove turbidity the absorbance of the solution is read at wave length of 420nm and the solutioncolor is calculated

C3 Definitions

For the purpose of this test method the following definitions shall apply.

C3.1
ICUMSA color
shall mean the value of absorbance index multiplied by 1000. The resulting values are designated as ICUMSA units (IU).

C4 Reagents

C4.1 Hydrochloric acid solution, 0.1M

C4.2 Sodium hydroxide solution 0.1M

C4.3 Celite filter aid;

C5 Apparatus

C5.1 Spectrophotometer, capable of measuring absorbance at 420nm;

C5.2 Optical cell:- Length 1cm, 2cm and 5cm;

C.5.4 $_{P}$H meter;

C5.5 Refractometer;

C5.6 Magnetic stirrer;

C5.7 Ultrasonic bath;

C.5.8 Analytical balance.

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C6 Procedure

C6.1 Mix the sample sugar thoroughly. Weigh accurately 30.0 ± 1g of sample and dissolve in 70 ± 1 ml of distilled water in 250ml conical flask.

C6.2 Filter the sample solution through membrane filter into clean, dry conical flask. If the solution is slow filtering use filter aid (1% on sugar mass) Discard the first portion of the filtrate if cloudy.

C6.3 Adjust the pH of the solution to 7.0 ± 0.1 by adding 0.1 M hydrochloric acid or 0.1 M sodium hydroxide solution as required. Stir the solution continuously with a magnetic stirrer while the pH is being adjusted.

C6.4 De-aerate by immersing the conical flask containing the sugar solution, in an ultrasonic bath for 3 minutes.

C6.5 Measure the refractometric dry substance (RDS) or brix of the solution as prescribed in Annex H

C6.6 Set up the spectophotometer according to the manufacturers instruction. Measure absorbance of the sample solution at 420 nm using filtered de-aerated distilled water as the reference standard for zero color.

C7 Calculation

C7.1 Calculate the concentration of sample solids in solution, C, from the RDS measured in section C6.5.

C7.2 Use the RDS to obtain the density of the test solution d in kg/m^3 from Annex H

$$c = \frac{RDS}{10^5} xdg/m$$

$$ICUMSA \quad Colour = \frac{1000 xAs}{bc}$$

$$= \frac{10^8 xAs}{bxRDSxd} \quad IU$$

Where

b length of the cell;

C concentration of the sample solution;

As absorbance read;

d density of the test solution in kg/m^3 from annex G

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Annex D
(normative)

D. Determination of Insoluble matter

1 Apparatus

1.1 Filtration Apparatus Comprising a holder for filter paper of 5cm fitted with a conical filtration flask of 500ml capacity connected to a vacuum pump.

1.2 Filter paper whatman No.54 or equivalent

1.3 Petridishes with lids

1.4 Desiccator

1.5 Analytical balance

2 Procedure

2.1 Mount a whatman No.54 filter paper on the filtration apparatus, filter hot distilled water at 95 ^{0}C through the filter paper to wash it free from water-soluble matter.

2.2 Transfer the filter paper to a clean dry petridish with lid and dry in an oven at 105 ±1^{0}C for 1 hour with the lid removed. The lid is replaced prior to cooling ina desiccator.

2.3 Weigh the paper in the petridish

2.4 Dissolve 100g of the raw sugar sample in 300g of distilled water water in a beaker and heat the solution to 95^{0}C.

2.5 Place the filter paper on the filtration apparatus and filter the hot sugar solution using vacuum.

2.6 Wash all insoluble from the beaker on to the filter paper and wash filter paper free of all trace of sugar with at least 1 litre of hot distilled water at 95^{0}C.

2.7 Return the filter paper to its original dish and dry, with the lid removed, for 3 hours at 105±1^{0}C. After replacing the lid, allow the dish to cool in a desiccator and reweigh.

Insoluble matter % by mass = $\frac{F_2 - F_1}{W} x100$

Where

F_1 filter paper after drying

F2 Filter paper and residue after drying

W Weight of sample taken for test

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Annex E
(normative)

E. Determination of starch

E1. Scope

This method specifies determination of starch in raw sugar.

1.1 . The method is dependant on the type of starch used for calibration. corn starch with 55% amylose more risible cane starch; potato starch is usually employed as standard and linter starch is also frequently used because it is easily solubilized.

E 2. Principle

2.1 The raw sugar solution is first digested with calcium chloride/acetic acid reagent, where by starch is dissolved and dispersed in Calcium chloride solution and subsequently reacts with potassium iodide/iodate reagent to produce the intense blue color complex of amylose/iodine, which is measured at 700nm.

E 3 Apparatus

3.1 Volumetric flasks 1L, 100ml, 50ml, 25ml

3.2 Plastic funnels, short stem

3.3 Pipettes 50, 25, 20, 10 and 5ml

3.4 P^H meter

3.5 Stirrer

3.6 Conical flasks

3.7 Flask Shaker

3.8 Spectrophotometer

3.9 Burette 50ml

E 4 Reagents

4.1 Calcium chloride solution (40% w/w)

4.1.1. Dissolve 53.0 ±0.1g AR grade calcium chloride dihydrate in a 100ml volumetric flask with distilled water and make up to mark to give a 40% w/v solution of anhydrous calcium chloride (do not expose to air)

4.1.2. Check the strength of the calcium chloride solution by measuring its specific gravity for 40% w/w solution, sp.gr. should be 1.3942 at 24 ^{0}C/24^{0}C between 20 -30^{0}C, it decreases on average by 0.007/ ^{0}C above 24 ^{0}C and increases by the same amount/^{0}C below 24^{0}C

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$$\text{SP.gr. of } CaCl_2 \text{ solution at } 24^0C/24^0C = \frac{\text{Weight of 100 ml of solution} + 0.0007(t-24)}{\text{Weight of 100 ml of distilled water}}$$

Calculate $CaCl_2$ concentration from specific gravity results at 24 ^{0}c/24^{0}c. A change of 0.001 in specific gravity produces a directly proportional change of 0.1% CaCl2 concentration in the region of 40%. (40g/100g).

4.2 Acetic acid solution 1 M

Dilute 57 ± 1 ml of glacial acetic acid to one litre with distilled water.

4.3 Acetic acid solution 0.1 M

Dilute 10 ml of 1 M acetic acid to 100 ml in a volumetric flask with distilled water.

4.4 Calcium chloride-acetic acid reagent

Using a $_P$H meter and stirrer, adjust the $_P$H of a 100 ml aliquot of the calcium chloride solution to $_P$H 3.0 ± 0.1 with 0.1 M acetic acid, allowing sufficient time for the $_P$H meter to come to equilibrium. Adjust the $_P$H of the bulk of the $CaCl_2$ solution to $_P$H 3.0 in the same way. Do not adjust again even if, on standing, the $_P$H changes from 3.0.

4.5 Potassium Iodate solution 0.01M

Dry potassium iodate at 105 ^{0}C for 2 hours. After cooling, weigh out 0.3566 gm, dissolve in distilled water in a 1 litre volumetric flask and make up to mark. Store in a glass stoppered brown bottle.

4.6 Potassium Iodide Solution (10 %)

Dissolve 10 gms potassium iodide in a 100 ml volumetric flask with distilled water and make up to mark. Store in a glass stoppered brown bottle. The solution must be in a glass stoppered brown bottle. The solution must be discarded when it becomes yellow.

4.7 Potassium Iodide-iodate reagent

This must be prepared on the day it is to be used. Take one part of potassium iodide solution (10%), add 9 parts of distilled water and mix. To this solution add on equal volume of potassium iodate reagent. Mix and keep in a brown stoppered bottle.

4.8 Standard starch solution (0.4 gm/Litre) anhydrous starch.

4.8.1 Determine the moisture content of the starch by drying about 2 gms at 105^{0}C for 2 hours.

4.8.2 Weigh into a 50 ml beaker a quantity of starch equivalent to a dry weight of 0.4 gm.

i.e. $\dfrac{0.4 \times 100}{100 - \%\text{ moisture in starch}}$

4.8.3 Add 5 ml of distilled water to the weighed starch and mix with a glass rod.

4.8.4 Boil 500 ml water in a conical flask. Transfer the starch slurry quantitatively to the boiling water adding the washings to the boiling water. The transfer should be done as quickly as possible.

4.8.5 Boil the starch for 3 minutes ± 10 seconds, timed from the moment the first 5 ml of starch slurry enters the boiling water.

4.8.6 Transfer quantitatively the hot solution to a 1 liter volumetric flask, wash the boiling-flask with hot distilled water and transfer washings to the liter flask until contents are about 900 ml. Cool the flask under running tap water, make up to mark and store in a refrigerator. (This solution will keep for a week).

E 5. Procedure

5.1 Standard curve preparation

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5.1.1 Take eight 100 ml volumetric flasks

5.1.2 Add 40 gm AR sucrose to each of the flasks

5.1.3 Pipette 0, 5, 10, 15, 20, 25, 30 and 50 ml aliquots of the standard starch solution in to the eight flasks. The concentration of starch in each flask will be 0, 50, 100, 150, 200, 250, 300, 500 mg starch/kg sugar. Add sufficient distilled water to each flask to bring the total volume to about 75 ml. Dissolve the sugar completely. Make up to mark with distilled water.

5.1.4 Take eight 50 ml volumetric flasks and pipette 15 ml of each solution.

5.1.5 Run in 25 ml of calcium chloride-acetic reagent from burette to each flask. Mix thoroughly a net place the flasks in a boiling water bath at a temperature of 95 to 100 ^{0}C, for 15 minutes, timed from the moment the flask is placed in the bath.

5.1.6 After 5 and 10 minutes the flasks should be swirled to facilitate the escape of gases.

5.1.7 Remove the flasks from the bath and cool in a water bath to room temperature. Make up to mark with distilled water.

5.1.8 Set a two sets of 25 ml flasks for each of the eight standard solutions and into each flask pipette 15 ml of the test solution. A pair of flasks is required as one is for the "blank". To each flask add 2.5 ml of 1 M acetic acid. Bring the "blank set" of eight flasks to the mark with distilled water.

5.1.9 Transfer the 0 mg/kg "blank" solution to a 1 cm cell and adjust the spectrophotometer at 700 nm to read zero absorbance. Remove any bubble from the cuvette.

5.1.10 To the 0 mg/kg test solution, add 5 ml of potassium iodide-iodate reagent, swirl to mix, make up to 25 ml mark and mix. Immediately transfer to a 1 cm cuvettee and read the absorbance at 700 nm. The absorbance must be read within 5 minutes of the addition of the iodide-iodate solution.

5.1.11 Repeat sections 5.1.9 and 5.1.10 for each concentration starch involved in the standardization ad record the absorbance for each concentration.

5.1.12 Prepare a graph of mg starch per kg sugar against absorbance

E 5.2 Determination.

5.2.1 Weigh 40 gms of raw sugar and transfer quantitatively to 100 ml volumetric flask, dissolve the sugar. Completely in about 50 ml distilled water and make up to mark.

5.2.2 Pipette 15 ml into a 50 ml volumetric flask and add 25 ml calcium chloride-acetic acid reagent.

5.2.3 Mix and place in a boiling water bath for 15 ± 1 minutes, timed from the moment the flask is placed in the bath.

5.2.4 Agitate the flask after 5 and 10 minutes. Remove the flask, cool in a water bath to room temperature and make up to mark with distilled water stopper, mix and filter.

5.2.5 Take two volumetric flasks of 25 ml capacity.

5.2.6 Pipette 15 ml into each of two volumetric flasks.

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5.2.7 Add 2.5 ml of 1 M acetic acid to each of the two flasks.

5.2.8 Make up to mark with distilled water one of the volumetric flask this is the blank solution.

5.2.9 Fill 1 cm cell (cuvette) with the blank solution adjust the spectrophotometer at zero absorbance.

5.2.10 To the other 25 ml volumetric flask add 5 ml potassium iodide -iodate reagent and make up to mark with distilled water. Mix

5.2.11 Fill 1 cm cell with this test solution and immediately read the absorbance at 700 nm.

5.2.12 Read the concentration of starch (mg starch per kg sugar) from the calibration curve prepared. Then convert the concentration to starch % by mass.

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Annex F
(normative)

F. Determination of Dextran in Raw Sugar

F1. Scope

This method is applicable to cane raw sugar and dependent on the molecular weight of dextrin used for calibration.

F2. Principle

In 50% alcohol, dextran forms quantitatively a haze, which is measured spectrophotometrically at 720 nm. Other substances which also form a haze under the same experimental conditions must be removed.

Suspended maters are removed by filtration

Soluble starch is removed by an enzyme

Protein is precipitated by trichloroacetic acid solution

Inorganic ions are eliminated by an ion exchanger.

F3. Apparatus

3.1 Spectrophotometer – capable of measuring absorbance at 720 nm with matched 2 cm cells.

3.2 Water baths maintained at 55 ^{0}C.

3.3 Analytical balance

3.4 Volumetric flasks 500, 200, 100 and 25 ml

3.5 Pipettes – 10 ml, 5 ml, 4 ml, 2 ml, 1 ml

3.6 Stopwatch

3.7 Fennel-to fit in to 100 ml volumetric flask

3.8 Buchner funnel and flask

3.9 Burettes 25 and 50 ml capacity

3.10 Whatman No. 5 filter paper or equivalent

3.11 Flask shaker

3.12 Conical flask

3.13 Beaker 150 ml

3.14 Oven, maintained at 105^{0}C.

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F4. Reagents

4.1 Standard dextran

4.1.1 Determine the moisture content of Dextran by weighing out 2 ± 0.0001 g and drying in an oven at 105 0C for 3 hours. Record the weights to 0.1 mg.

4.1.2 Standard dextran solution 0.8 mg/ml.

4.1.3 Quickly weigh a quantity of the undried dextran that contains 0.15 gm of anhydrous dextran.

i.e. weigh out $\frac{0.16 \times 100}{100 - \%\ \text{moisture in dextran}}$ of undried dextran into a 100 ml beaker

4.1.4 Dissolve the dextran by adding 1 to 2 ml of distilled water to form slurry.

4.1.5 Allow the particles to be come uniformly hydrated by standing for about 10 minutes with occasional stirring.

4.1.6 Add more water in small aliquots while a gel mass remains.

4.1.7 When about 25 ml has been added and no gel is present wash the slurry into 200 ml volumetric flask with water to a volume of about 80 ml.

4.1.8 Place the flask in boiling water bath for 30 minutes.

4.1.9 Cool to room temperature in a cold water and then make up to the mark with water. Prepare the standard dextran solution daily, do not store overnight.

4.2 Standard dextran solution (0.08 mg/ml)

4.2.1 Pipette 10 ml of the standard dextran (4.2) into a 100 ml volumetric flask, dilute to the mark and mix well.

4.3 Trichloroacetic acid (TCA) 10% W/V

4.4.1 Dissolve 20 ± 0.1 gms of trichloroacetic acid in distilled water and dilute to 200 ml. This reagent will keep for two weeks; stored under refrigeration in a dark brown bottle.

4.5 Denatured absolute alcohol (DAA)

4.5.1 Absolute ethanol with 2.0 ± 0.2% of methanol, and with a water content of less than 0.55 m/m. If visible particles are present filter through whatman filter paper No. 5 store in a tight container.

4.6 Sucrose TCA solution

4.6.1 Dissolve 250 ± 0.1 gm of standard sucrose in distilled water in a 500 ml volumetric flask add 78 ml TCA solution, make up to the mark and mix (This solution should be made up freshly as required)

4.7 Starch removing enzyme heat stable α - amylase

e.g. Kleistase

4.8 Acid washed filter aid

4.8.1 Add 50 ± 5 g of Kielselglaur (supercel) to 1 L distilled water, add 50 ± 5 ml of concentrated hydrochloric acid to the mixture and stir for 5 minutes.

4.8.2 Filter the Kieslghur on a large Buchner funnel and wash with distilled water until free from acid by checking with litmus paper.

4.8.3 Dry the Kieslguhr for 6 hours at 96-100 ^{0}C and store in a closed container.

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F**5. Procedure**

5.1 Preparation of standards and calibration graph.

5.1.1 Pipette 8 ml of the sucrose/TCA solution (4.6) to each of eight 25 ml of volumetric flasks.

5.1.2 To one of the flasks add distilled water to 25 ml mark. This is the blank solution.

5.1.3 Using 5ml pipette add 0, 0.5, 1, 1.5, 2, 3, 4 ml respectively of standard dextran solution to the seven remaining flasks. Then add distilled water to obtain a total volume of 12.5ml in each of these flasks, i.e. add 4.5, 4, 3.5, 3, 2.5, 1.5, 0.5 ml distilled water to the respective flask.

5.1.4 Add denatured absolute alcohol (4.5) slowly from a 50ml burette to the 25ml mark to the first of the seven volumetric flasks while gently swirling the flask. The time of the alcohol addition should be between 30 and 60 seconds, mix the contents of the flask by inverting gently three times. Start the stopwatch immediately after the mixing step is completed.

5.1.5 About 17 - 18 minutes after completion of the mixing step, rinse a cell three times with the blank solution and then fill the cell. In a similar way, rinse and fill the other cell with one of the standard solutions.

5.1.6 At 20 minutes ±10 seconds after completion of the mixing step, read and record the absorbance the test solution against the blank solution at 720nm.

5.1.7 Repeat the above two steps (5.1.5 and 5.1.6) for each dextran standard. (The blank solution filled once can be used for all steps).

5.1.8 Calculate the actual concentration of dextran in each flask using the moisture in the dextran, and the actual weight taken.

5.1.9 Plot actual dextran concentration mg/kg against absorbance for each standard and draw the curve of best fit. The calibration graph should be a gradual curve at low dextran concentration and become almost linear at high dextran concentration.

F5.2 Determination

5.2.1 Weigh out 32.0 ±0.1g of raw sugar, transfer to a 200ml conical flasks, add 50ml of distilled water, stopper and dissolve.

5.2.2 Add 0.1 ml of the starch enzyme. Mix well and stopper the flask.

5.2.3 Place the flask in a shaking water bath at 55 ± 5^{0}C for 15 ±2 minutes. Cool the flask to room temperature in a cold water bath.

5.2.4 Transfer the mixture through a funnel into 100ml volumetric flask, rinse the flask with distilled water thoroughly and add through the funnel into the volumetric flask.

5.2.5 Add 10±0.1ml TCA(4.4) solution, make up to the mark, stopper and mix well.

5.2.6 Pour the solution into a 150ml beaker. Ad 6 -8gm of acid washed kieselguhr and mix. Filter the mixture through Buchner funnel with whatman No.5 filter paper under vacuum using the first 10 to 15ml of the filtrate to rinse the funnel and flask.

5.2.7 Using a 25ml graduated burette, add 12.5ml of the filtrate to each of two clean, dry 25ml volumetric flasks.

5.2.8 Add denatured absolute alcohol (4.5) slowly from a 50ml burette to the 25ml mark to one of the flasks, gently swirling the flask. The time for the alcohol addition should be between 30 and 60 seconds. Mix the contents of the flask by inverting gently three times. Start the stopwatch immediately after mixing step is completed.

5.2.9 To the other flask add distilled water to the 25ml mark and mix. This is the test blank.

5.2.10 About 17-18 minutes after the completion of the mixing step rinse the reference cell three times with the blank solution and than fill the cell,

5.2.11 In a similar way, rinse and fill the other cell with the test solution.

5.2.12 At 20 min ± 10 seconds after the completion of the mixing step read the absorbance of the test solution against that of the blank solution at 720nm.

5.2.13 Immediately after reading, visually inspect the contents of the test solution cell to check for flocculation. If the haze has flocculated repeat the analysis.

5.2.14 If the dextran haze absorbance is higher than the upper limit of the calibration graph. Repeat the determination by diluting the sample with standard sucrose (sugar)

e.g. 16±0.1g of sample with 16±0.1g of standard sugar. Their total equal to 32 gms.

Note. Add alcohol within 20 minutes of addition of the TCA solution. Avoid vigorous shaking of the flask as it may cause coagulation of the dextran haze.

5.2.15 Calculation

- Obtain the dextran concentration in the raw sugar directly from the standard curve by reading against the corresponding solution absorbance.
- If the sample was mixed with standard sugar, multiply the result by the dilution factor. Express results to the nearest mg/kg sugar.

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Annex G
(normative)

Refractive Indices (*n*) of sucrose solutions at 20°—*Continued.*

n 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %
1.3580	16.449	1.3630	19.503	1.3680	22.487	1.3730	25.403	1.3780	28.253
1.3581	16.511	1.3631	19.564	1.3681	22.546	1.3731	25.460	1.3781	28.310
1.3582	16.573	1.3632	19.624	1.3682	22.605	1.3732	25.518	1.3782	28.366
1.3583	16.634	1.3633	19.684	1.3683	22.664	1.3733	25.576	1.3783	28.422
1.3584	16.696	1.3634	19.745	1.3684	22.723	1.3734	25.633	1.3784	28.479
1.3585	16.758	1.3635	19.805	1.3685	22.781	1.3735	25.691	1.3785	28.535
1.3586	16.819	1.3636	19.865	1.3686	22.840	1.3736	25.748	1.3786	28.591
1.3587	16.881	1.3637	19.925	1.3687	22.899	1.3737	25.806	1.3787	28.648
1.3588	16.943	1.3638	19.985	1.3688	22.958	1.3738	25.863	1.3788	28.704
1.3589	17.004	1.3639	20.045	1.3689	23.017	1.3739	25.921	1.3789	28.760
1.3590	17.066	1.3640	20.106	1.3690	23.075	1.3740	25.978	1.3790	28.816
1.3591	17.127	1.3641	20.166	1.3691	23.134	1.3741	26.035	1.3791	28.872
1.3592	17.189	1.3642	20.226	1.3692	23.193	1.3742	26.093	1.3792	28.928
1.3593	17.250	1.3643	20.286	1.3693	23.251	1.3743	26.150	1.3793	28.984
1.3594	17.311	1.3644	20.346	1.3694	23.310	1.3744	26.207	1.3794	29.040
1.3595	17.373	1.3645	20.406	1.3695	23.369	1.3745	26.265	1.3795	29.096
1.3596	17.434	1.3646	20.466	1.3696	23.427	1.3746	26.322	1.3796	29.152
1.3597	17.496	1.3647	20.525	1.3697	23.486	1.3747	26.379	1.3797	29.208
1.3598	17.557	1.3648	20.585	1.3698	23.544	1.3748	26.436	1.3798	29.264
1.3599	17.618	1.3649	20.645	1.3699	23.603	1.3749	26.493	1.3799	29.320
1.3600	17.679	1.3650	20.705	1.3700	23.661	1.3750	26.551	1.3800	29.376
1.3601	17.741	1.3651	20.765	1.3701	23.720	1.3751	26.608	1.3801	29.432
1.3602	17.802	1.3652	20.825	1.3702	23.778	1.3752	26.665	1.3802	29.488
1.3603	17.863	1.3653	20.884	1.3703	23.836	1.3753	26.722	1.3803	29.544
1.3604	17.924	1.3654	20.944	1.3704	23.895	1.3754	26.779	1.3804	29.600
1.3605	17.985	1.3655	21.004	1.3705	23.953	1.3755	26.836	1.3805	29.655
1.3606	18.046	1.3656	21.063	1.3706	24.011	1.3756	26.893	1.3806	29.711
1.3607	18.107	1.3657	21.123	1.3707	24.070	1.3757	26.950	1.3807	29.767
1.3608	18.168	1.3658	21.183	1.3708	24.128	1.3758	27.007	1.3808	29.823
1.3609	18.229	1.3659	21.242	1.3709	24.186	1.3759	27.064	1.3809	29.878
1.3610	18.290	1.3660	21.302	1.3710	24.244	1.3760	27.121	1.3810	29.934
1.3611	18.351	1.3661	21.361	1.3711	24.302	1.3761	27.178	1.3811	29.989
1.3612	18.412	1.3662	21.421	1.3712	24.361	1.3762	27.234	1.3812	30.045
1.3613	18.473	1.3663	21.480	1.3713	24.419	1.3763	27.291	1.3813	30.101
1.3614	18.534	1.3664	21.540	1.3714	24.477	1.3764	27.348	1.3814	30.156
1.3615	18.595	1.3665	21.599	1.3715	24.535	1.3765	27.405	1.3815	30.212
1.3616	18.655	1.3666	21.658	1.3716	24.593	1.3766	27.462	1.3816	30.267
1.3617	18.716	1.3667	21.718	1.3717	24.651	1.3767	27.518	1.3817	30.323
1.3618	18.777	1.3668	21.777	1.3718	24.709	1.3768	27.575	1.3818	30.378
1.3619	18.837	1.3669	21.836	1.3719	24.767	1.3769	27.632	1.3819	30.434
1.3620	18.898	1.3670	21.896	1.3720	24.825	1.3770	27.688	1.3820	30.489
1.3621	18.959	1.3671	21.955	1.3721	24.883	1.3771	27.745	1.3821	30.544
1.3622	19.019	1.3672	22.014	1.3722	24.941	1.3772	27.802	1.3822	30.600
1.3623	19.080	1.3673	22.073	1.3723	24.998	1.3773	27.858	1.3823	30.655
1.3624	19.141	1.3674	22.132	1.3724	25.056	1.3774	27.915	1.3824	30.711
1.3625	19.201	1.3675	22.192	1.3725	25.114	1.3775	27.971	1.3825	30.766
1.3626	19.262	1.3676	22.251	1.3726	25.172	1.3776	28.028	1.3826	30.821
1.3627	19.322	1.3677	22.310	1.3727	25.230	1.3777	28.084	1.3827	30.876
1.3628	19.382	1.3678	22.369	1.3728	25.287	1.3778	28.141	1.3828	30.932
1.3629	19.443	1.3679	22.428	1.3729	25.345	1.3779	28.197	1.3829	30.987

(Continued)

970.91 **Refractive Indices (n) of sucrose solutions at 20°—*Continued.***

n 20°	Sucrose, %	n 20°	Sucrose, %	n 20°	Sucrose, %	n 20°	Sucrose, %	n 20°	Sucrose, %
1.3830	31.042	1.3880	33.771	1.3930	36.442	1.3980	39.059	1.4030	41.623
1.3831	31.097	1.3881	33.825	1.3931	36.495	1.3981	39.111	1.4031	41.674
1.3832	31.152	1.3882	33.879	1.3932	36.548	1.3982	39.163	1.4032	41.725
1.3833	31.207	1.3883	33.933	1.3933	36.601	1.3983	39.214	1.4033	41.776
1.3834	31.262	1.3884	33.987	1.3934	36.654	1.3984	39.266	1.4034	41.826
1.3835	31.317	1.3885	34.040	1.3935	36.706	1.3985	39.318	1.4035	41.877
1.3836	31.372	1.3886	34.094	1.3936	36.759	1.3986	39.370	1.4036	41.928
1.3837	31.428	1.3887	34.148	1.3937	36.812	1.3987	39.421	1.4037	41.978
1.3838	31.482	1.3888	34.202	1.3938	36.865	1.3988	39.473	1.4038	42.029
1.3839	31.537	1.3889	34.256	1.3939	36.917	1.3989	39.525	1.4039	42.080
1.3840	31.592	1.3890	34.310	1.3940	36.970	1.3990	39.576	1.4040	42.130
1.3841	31.647	1.3891	34.363	1.3941	37.023	1.3991	39.628	1.4041	42.181
1.3842	31.702	1.3892	34.417	1.3942	37.075	1.3992	39.679	1.4042	42.231
1.3843	31.757	1.3893	34.471	1.3943	37.128	1.3993	39.731	1.4043	42.282
1.3844	31.812	1.3894	34.524	1.3944	37.180	1.3994	39.782	1.4044	42.332
1.3845	31.867	1.3895	34.578	1.3945	37.233	1.3995	39.834	1.4045	42.383
1.3846	31.922	1.3896	34.632	1.3946	37.286	1.3996	39.885	1.4046	42.433
1.3847	31.976	1.3897	34.685	1.3947	37.338	1.3997	39.937	1.4047	42.484
1.3848	32.031	1.3898	34.739	1.3948	37.391	1.3998	39.988	1.4048	42.534
1.3849	32.086	1.3899	34.793	1.3949	37.443	1.3999	40.040	1.4049	42.585
1.3850	32.140	1.3900	34.846	1.3950	37.495	1.4000	40.091	1.4050	42.635
1.3851	32.195	1.3901	34.900	1.3951	37.548	1.4001	40.142	1.4051	42.685
1.3852	32.250	1.3902	34.953	1.3952	37.600	1.4002	40.194	1.4052	42.736
1.3853	32.304	1.3903	35.007	1.3953	37.653	1.4003	40.245	1.4053	42.786
1.3854	32.359	1.3904	35.060	1.3954	37.705	1.4004	40.296	1.4054	42.836
1.3855	32.414	1.3905	35.114	1.3955	37.757	1.4005	40.348	1.4055	42.887
1.3856	32.468	1.3906	35.167	1.3956	37.810	1.4006	40.399	1.4056	42.937
1.3857	32.523	1.3907	35.220	1.3957	37.862	1.4007	40.450	1.4057	42.987
1.3858	32.577	1.3908	35.274	1.3958	37.914	1.4008	40.501	1.4058	43.037
1.3859	32.632	1.3909	35.327	1.3959	37.967	1.4009	40.553	1.4059	43.088
1.3860	32.686	1.3910	35.380	1.3960	38.019	1.4010	40.604	1.4060	43.138
1.3861	32.741	1.3911	35.434	1.3961	38.071	1.4011	40.655	1.4061	43.188
1.3862	32.795	1.3912	35.487	1.3962	38.123	1.4012	40.706	1.4062	43.238
1.3863	32.849	1.3913	35.540	1.3963	38.175	1.4013	40.757	1.4063	43.288
1.3864	32.904	1.3914	35.593	1.3964	38.228	1.4014	40.808	1.4064	43.338
1.3865	32.958	1.3915	35.647	1.3965	38.280	1.4015	40.860	1.4065	43.388
1.3866	33.013	1.3916	35.700	1.3966	38.332	1.4016	40.911	1.4066	43.439
1.3867	33.067	1.3917	35.753	1.3967	38.384	1.4017	40.962	1.4067	43.489
1.3868	33.121	1.3918	35.806	1.3968	38.436	1.4018	41.013	1.4068	43.539
1.3869	33.175	1.3919	35.859	1.3969	38.488	1.4019	41.064	1.4069	43.589
1.3870	33.230	1.3920	35.912	1.3970	38.540	1.4020	41.115	1.4070	43.639
1.3871	33.284	1.3921	35.966	1.3971	38.592	1.4021	41.166	1.4071	43.689
1.3872	33.338	1.3922	36.019	1.3972	38.644	1.4022	41.217	1.4072	43.739
1.3873	33.392	1.3923	36.072	1.3973	38.696	1.4023	41.268	1.4073	43.789
1.3874	33.446	1.3924	36.125	1.3974	38.748	1.4024	41.318	1.4074	43.838
1.3875	33.500	1.3925	36.178	1.3975	38.800	1.4025	41.369	1.4075	43.888
1.3876	33.555	1.3926	36.231	1.3976	38.852	1.4026	41.420	1.4076	43.938
1.3877	33.609	1.3927	36.284	1.3977	38.904	1.4027	41.471	1.4077	43.988
1.3878	33.663	1.3928	36.337	1.3978	38.955	1.4028	41.522	1.4078	44.038
1.3879	33.717	1.3929	36.389	1.3979	39.007	1.4029	41.573	1.4079	44.088

(Continued)

Refractive Indices (*n*) of sucrose solutions at 20°—*Continued.*

n 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %
1.4080	44.138	1.4130	46.604	1.4180	49.023	1.4230	51.399	1.4280	53.733
1.4081	44.187	1.4131	46.652	1.4181	49.071	1.4231	51.446	1.4281	53.779
1.4082	44.237	1.4132	46.701	1.4182	49.119	1.4232	51.493	1.4282	53.825
1.4083	44.287	1.4133	46.750	1.4183	49.167	1.4233	51.540	1.4283	53.871
1.4084	44.337	1.4134	46.799	1.4184	49.215	1.4234	51.587	1.4284	53.918
1.4085	44.386	1.4135	46.848	1.4185	49.263	1.4235	51.634	1.4285	53.964
1.4086	44.436	1.4136	46.896	1.4186	49.311	1.4236	51.681	1.4286	54.010
1.4087	44.486	1.4137	46.945	1.4187	49.359	1.4237	51.728	1.4287	54.056
1.4088	44.535	1.4138	46.994	1.4188	49.407	1.4238	51.775	1.4288	54.102
1.4089	44.585	1.4139	47.043	1.4189	49.454	1.4239	51.822	1.4289	54.148
1.4090	44.635	1.4140	47.091	1.4190	49.502	1.4240	51.869	1.4290	54.194
1.4091	44.684	1.4141	47.140	1.4191	49.550	1.4241	51.916	1.4291	54.241
1.4092	44.734	1.4142	47.188	1.4192	49.598	1.4242	51.963	1.4292	54.287
1.4093	44.783	1.4143	47.237	1.4193	49.645	1.4243	52.010	1.4293	54.333
1.4094	44.833	1.4144	47.286	1.4194	49.693	1.4244	52.057	1.4294	54.379
1.4095	44.882	1.4145	47.334	1.4195	49.741	1.4245	52.104	1.4295	54.425
1.4096	44.932	1.4146	47.383	1.4196	49.788	1.4246	52.150	1.4296	54.471
1.4097	44.981	1.4147	47.431	1.4197	49.836	1.4247	52.197	1.4297	54.517
1.4098	45.031	1.4148	47.480	1.4198	49.884	1.4248	52.244	1.4298	54.563
1.4099	45.080	1.4149	47.528	1.4199	49.931	1.4249	52.291	1.4299	54.609
1.4100	45.130	1.4150	47.577	1.4200	49.979	1.4250	52.338	1.4300	54.655
1.4101	45.179	1.4151	47.625	1.4201	50.027	1.4251	52.384	1.4301	54.701
1.4102	45.228	1.4152	47.674	1.4202	50.074	1.4252	52.431	1.4302	54.746
1.4103	45.278	1.4153	47.722	1.4203	50.122	1.4253	52.478	1.4303	54.792
1.4104	45.327	1.4154	47.771	1.4204	50.169	1.4254	52.524	1.4304	54.838
1.4105	45.376	1.4155	47.819	1.4205	50.217	1.4255	52.571	1.4305	54.884
1.4106	45.426	1.4156	47.868	1.4206	50.264	1.4256	52.618	1.4306	54.930
1.4107	45.475	1.4157	47.916	1.4207	50.312	1.4257	52.664	1.4307	54.976
1.4108	45.524	1.4158	47.964	1.4208	50.359	1.4258	52.711	1.4308	55.022
1.4109	45.574	1.4159	48.013	1.4209	50.407	1.4259	52.758	1.4309	55.067
1.4110	45.623	1.4160	48.061	1.4210	50.454	1.4260	52.804	1.4310	55.113
1.4111	45.672	1.4161	48.109	1.4211	50.502	1.4261	52.851	1.4311	55.159
1.4112	45.721	1.4162	48.158	1.4212	50.549	1.4262	52.897	1.4312	55.205
1.4113	45.770	1.4163	48.206	1.4213	50.596	1.4263	52.944	1.4313	55.250
1.4114	45.820	1.4164	48.254	1.4214	50.644	1.4264	52.990	1.4314	55.296
1.4115	45.869	1.4165	48.302	1.4215	50.691	1.4265	53.037	1.4315	55.342
1.4116	45.918	1.4166	48.350	1.4216	50.738	1.4266	53.083	1.4316	55.388
1.4117	45.967	1.4167	48.399	1.4217	50.786	1.4267	53.130	1.4317	55.433
1.4118	46.016	1.4168	48.447	1.4218	50.833	1.4268	53.176	1.4318	55.479
1.4119	46.065	1.4169	48.495	1.4219	50.880	1.4269	53.223	1.4319	55.524
1.4120	46.114	1.4170	48.543	1.4220	50.928	1.4270	53.269	1.4320	55.570
1.4121	46.163	1.4171	48.591	1.4221	50.975	1.4271	53.316	1.4321	55.616
1.4122	46.212	1.4172	48.639	1.4222	51.022	1.4272	53.362	1.4322	55.661
1.4123	46.261	1.4173	48.687	1.4223	51.069	1.4273	53.408	1.4323	55.707
1.4124	46.310	1.4174	48.735	1.4224	51.116	1.4274	53.455	1.4324	55.752
1.4125	46.359	1.4175	48.784	1.4225	51.164	1.4275	53.501	1.4325	55.79[illegible]
1.4126	46.408	1.4176	48.832	1.4226	51.211	1.4276	53.548	1.4326	55.844
1.4127	46.457	1.4177	48.880	1.4227	51.258	1.4277	53.594	1.4327	55.889
1.4128	46.506	1.4178	48.928	1.4228	51.305	1.4278	53.640	1.4328	55.935
1.4129	46.555	1.4179	48.976	1.4229	51.352	1.4279	53.686	1.4329	55.980

(Continued)

Refractive indices (*n*) of sucrose solutions at 20°—*Continued.*

n 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %
1.4330	56.026	1.4380	58.279	1.4430	60.496	1.4480	62.677	1.4530	64.823
1.4331	56.071	1.4381	58.324	1.4431	60.540	1.4481	62.720	1.4531	64.865
1.4332	56.116	1.4382	58.369	1.4432	60.584	1.4482	62.763	1.4532	64.908
1.4333	56.162	1.4383	58.413	1.4433	60.628	1.4483	62.806	1.4533	64.950
1.4334	56.207	1.4384	58.458	1.4434	60.672	1.4484	62.849	1.4534	64.993
1.4335	56.253	1.4385	58.503	1.4435	60.716	1.4485	62.893	1.4535	65.035
1.4336	56.298	1.4386	58.547	1.4436	60.759	1.4486	62.936	1.4536	65.078
1.4337	56.343	1.4387	58.592	1.4437	60.803	1.4487	62.979	1.4537	65.120
1.4338	56.389	1.4388	58.637	1.4438	60.847	1.4488	63.022	1.4538	65.163
1.4339	56.434	1.4389	58.681	1.4439	60.891	1.4489	63.065	1.4539	65.205
1.4340	56.479	1.4390	58.726	1.4440	60.935	1.4490	63.108	1.4540	65.248
1.4341	56.525	1.4391	58.770	1.4441	60.979	1.4491	63.152	1.4541	65.290
1.4342	56.570	1.4392	58.815	1.4442	61.023	1.4492	63.195	1.4542	65.333
1.4343	56.615	1.4393	58.859	1.4443	61.066	1.4493	63.238	1.4543	65.375
1.4344	56.660	1.4394	58.904	1.4444	61.110	1.4494	63.281	1.4544	65.417
1.4345	56.706	1.4395	58.948	1.4445	61.154	1.4495	63.324	1.4545	65.460
1.4346	56.751	1.4396	58.993	1.4446	61.198	1.4496	63.367	1.4546	65.502
1.4347	56.796	1.4397	59.037	1.4447	61.241	1.4497	63.410	1.4547	65.544
1.4348	56.841	1.4398	59.082	1.4448	61.285	1.4498	63.453	1.4548	65.587
1.4349	56.887	1.4399	59.126	1.4449	61.329	1.4499	63.496	1.4549	65.629
1.4350	56.932	1.4400	59.170	1.4450	61.372	1.4500	63.539	1.4550	65.672
1.4351	56.977	1.4401	59.215	1.4451	61.416	1.4501	63.582	1.4551	65.714
1.4352	57.022	1.4402	59.259	1.4452	61.460	1.4502	63.625	1.4552	65.756
1.4353	57.067	1.4403	59.304	1.4453	61.503	1.4503	63.668	1.4553	65.798
1.4354	57.112	1.4404	59.348	1.4454	61.547	1.4504	63.711	1.4554	65.841
1.4355	57.157	1.4405	59.392	1.4455	61.591	1.4505	63.754	1.4555	65.883
1.4356	57.202	1.4406	59.437	1.4456	61.634	1.4506	63.797	1.4556	65.925
1.4357	57.247	1.4407	59.481	1.4457	61.678	1.4507	63.840	1.4557	65.967
1.4358	57.292	1.4408	59.525	1.4458	61.721	1.4508	63.882	1.4558	66.010
1.4359	57.337	1.4409	59.569	1.4459	61.765	1.4509	63.925	1.4559	66.052
1.4360	57.382	1.4410	59.614	1.4460	61.809	1.4510	63.968	1.4560	66.094
1.4361	57.427	1.4411	59.658	1.4461	61.852	1.4511	64.011	1.4561	66.136
1.4362	57.472	1.4412	59.702	1.4462	61.896	1.4512	64.054	1.4562	66.178
1.4363	57.517	1.4413	59.746	1.4463	61.939	1.4513	64.097	1.4563	66.221
1.4364	57.562	1.4414	59.791	1.4464	61.983	1.4514	64.139	1.4564	66.263
1.4365	57.607	1.4415	59.835	1.4465	62.026	1.4515	64.182	1.4565	66.305
1.4366	57.652	1.4416	59.879	1.4466	62.070	1.4516	64.225	1.4566	66.347
1.4367	57.697	1.4417	59.923	1.4467	62.113	1.4517	64.268	1.4567	66.389
1.4368	57.742	1.4418	59.967	1.4468	62.156	1.4518	64.311	1.4568	66.431
1.4369	57.787	1.4419	60.011	1.4469	62.200	1.4519	64.353	1.4569	66.473
1.4370	57.832	1.4420	60.056	1.4470	62.243	1.4520	64.396	1.4570	66.515
1.4371	57.877	1.4421	60.100	1.4471	62.287	1.4521	64.439	1.4571	66.557
1.4372	57.921	1.4422	60.144	1.4472	62.330	1.4522	64.481	1.4572	66.599
1.4373	57.966	1.4423	60.188	1.4473	62.373	1.4523	64.524	1.4573	66.641
1.4374	58.011	1.4424	60.232	1.4474	62.417	1.4524	64.567	1.4574	66.683
1.4375	58.056	1.4425	60.276	1.4475	62.460	1.4525	64.609	1.4575	66.725
1.4376	58.101	1.4426	60.320	1.4476	62.503	1.4526	64.652	1.4576	66.767
1.4377	58.145	1.4427	60.364	1.4477	62.547	1.4527	64.695	1.4577	66.809
1.4378	58.190	1.4428	60.408	1.4478	62.590	1.4528	64.737	1.4578	66.851
1.4379	58.235	1.4429	60.452	1.4479	62.633	1.4529	64.780	1.4579	66.893

(Continued)

Refractive Indices (*n*) of sucrose solutions at 20°—*Continued*.

n 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %
1.4580	66.935	1.4630	69.016	1.4680	71.065	1.4730	73.084	1.4780	75.074
1.4581	66.977	1.4631	69.057	1.4681	71.106	1.4731	73.124	1.4781	75.114
1.4582	67.019	1.4632	69.098	1.4682	71.146	1.4732	73.164	1.4782	75.153
1.4583	67.061	1.4633	69.139	1.4683	71.187	1.4733	73.204	1.4783	75.193
1.4584	67.103	1.4634	69.181	1.4684	71.228	1.4734	73.244	1.4784	75.232
1.4585	67.145	1.4635	69.222	1.4685	71.268	1.4735	73.285	1.4785	75.272
1.4586	67.186	1.4636	69.263	1.4686	71.309	1.4736	73.325	1.4786	75.311
1.4587	67.228	1.4637	69.304	1.4687	71.349	1.4737	73.365	1.4787	75.350
1.4588	67.270	1.4638	69.346	1.4688	71.390	1.4738	73.405	1.4788	75.390
1.4589	67.312	1.4639	69.387	1.4689	71.431	1.4739	73.445	1.4789	75.429
1.4590	67.354	1.4640	69.428	1.4690	71.471	1.4740	73.485	1.4790	75.469
1.4591	67.396	1.4641	69.469	1.4691	71.512	1.4741	73.524	1.4791	75.508
1.4592	67.437	1.4642	69.510	1.4692	71.552	1.4742	73.564	1.4792	75.547
1.4593	67.479	1.4643	69.551	1.4693	71.593	1.4743	73.604	1.4793	75.587
1.4594	67.521	1.4644	69.593	1.4694	71.633	1.4744	73.644	1.4794	75.626
1.4595	67.563	1.4645	69.634	1.4695	71.674	1.4745	73.684	1.4795	75.666
1.4596	67.604	1.4646	69.675	1.4696	71.714	1.4746	73.724	1.4796	75.705
1.4597	67.646	1.4647	69.716	1.4697	71.755	1.4747	73.764	1.4797	75.744
1.4598	67.688	1.4648	69.757	1.4698	71.795	1.4748	73.804	1.4798	75.784
1.4599	67.729	1.4649	69.798	1.4699	71.836	1.4749	73.844	1.4799	75.823
1.4600	67.771	1.4650	69.839	1.4700	71.876	1.4750	73.884	1.4800	75.862
1.4601	67.813	1.4651	69.880	1.4701	71.917	1.4751	73.924	1.4801	75.901
1.4602	67.854	1.4652	69.921	1.4702	71.957	1.4752	73.963	1.4802	75.941
1.4603	67.896	1.4653	69.962	1.4703	71.998	1.4753	74.003	1.4803	75.980
1.4604	67.938	1.4654	70.003	1.4704	72.038	1.4754	74.043	1.4804	76.019
1.4605	67.979	1.4655	70.044	1.4705	72.078	1.4755	74.083	1.4805	76.058
1.4606	68.021	1.4656	70.085	1.4706	72.119	1.4756	74.123	1.4806	76.098
1.4607	68.063	1.4657	70.126	1.4707	72.159	1.4757	74.162	1.4807	76.137
1.4608	68.104	1.4658	70.167	1.4708	72.199	1.4758	74.202	1.4808	76.176
1.4609	68.146	1.4659	70.208	1.4709	72.240	1.4759	74.242	1.4809	76.215
1.4610	68.187	1.4660	70.249	1.4710	72.280	1.4760	74.282	1.4810	76.254
1.4611	68.229	1.4661	70.290	1.4711	72.320	1.4761	74.321	1.4811	76.294
1.4612	68.270	1.4662	70.331	1.4712	72.361	1.4762	74.361	1.4812	76.333
1.4613	68.312	1.4663	70.372	1.4713	72.401	1.4763	74.401	1.4813	76.372
1.4614	68.353	1.4664	70.413	1.4714	72.441	1.4764	74.441	1.4814	76.411
1.4615	68.395	1.4665	70.453	1.4715	72.482	1.4765	74.480	1.4815	76.450
1.4616	68.436	1.4666	70.494	1.4716	72.522	1.4766	74.520	1.4816	76.489
1.4617	68.478	1.4667	70.535	1.4717	72.562	1.4767	74.560	1.4817	76.528
1.4618	68.519	1.4668	70.576	1.4718	72.602	1.4768	74.599	1.4818	76.567
1.4619	68.561	1.4669	70.617	1.4719	72.643	1.4769	74.639	1.4819	76.607
1.4620	68.602	1.4670	70.658	1.4720	72.683	1.4770	74.678	1.4820	76.646
1.4621	68.643	1.4671	70.698	1.4721	72.723	1.4771	74.718	1.4821	76.685
1.4622	68.685	1.4672	70.739	1.4722	72.763	1.4772	74.758	1.4822	76.724
1.4623	68.726	1.4673	70.780	1.4723	72.803	1.4773	74.797	1.4823	76.763
1.4624	68.768	1.4674	70.821	1.4724	72.843	1.4774	74.837	1.4824	76.802
1.4625	68.809	1.4675	70.861	1.4725	72.884	1.4775	74.876	1.4825	76.841
1.4626	68.850	1.4676	70.902	1.4726	72.924	1.4776	74.916	1.4826	76.880
1.4627	68.892	1.4677	70.943	1.4727	72.964	1.4777	74.956	1.4827	76.919
1.4628	68.933	1.4678	70.984	1.4728	73.004	1.4778	74.995	1.4828	76.958
1.4629	68.974	1.4679	71.024	1.4729	73.044	1.4779	75.035	1.4829	76.997

(*Continued*)

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970.91 Refractive indices (*n*) of sucrose solutions at 20°—*Concluded.*

n 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %	*n* 20°	Sucrose, %
1.4830	77.036	1.4880	78.969	1.4930	80.876	1.4980	82.755	1.5030	84.609
1.4831	77.075	1.4881	79.008	1.4931	80.913	1.4981	82.793	1.5031	84.645
1.4832	77.113	1.4882	79.046	1.4932	80.951	1.4982	82.830	1.5032	84.682
1.4833	77.152	1.4883	79.084	1.4933	80.989	1.4983	82.867	1.5033	84.719
1.4834	77.191	1.4884	79.123	1.4934	81.027	1.4984	82.905	1.5034	84.756
1.4835	77.230	1.4885	79.161	1.4935	81.065	1.4985	82.942	1.5035	84.792
1.4836	77.269	1.4886	79.199	1.4936	81.103	1.4986	82.979	1.5036	84.829
1.4837	77.308	1.4887	79.238	1.4937	81.140	1.4987	83.016	1.5037	84.866
1.4838	77.347	1.4888	79.276	1.4938	81.178	1.4988	83.054	1.5038	84.903
1.4839	77.386	1.4889	79.314	1.4939	81.216	1.4989	83.091	1.5039	84.939
1.4840	77.425	1.4890	79.353	1.4940	81.254	1.4990	83.128	1.5040	84.976
1.4841	77.463	1.4891	79.391	1.4941	81.291	1.4991	83.165	1.5041	85.013
1.4842	77.502	1.4892	79.429	1.4942	81.329	1.4992	83.202	1.5042	85.049
1.4843	77.541	1.4893	79.468	1.4943	81.367	1.4993	83.240	1.5043	85.086
1.4844	77.580	1.4894	79.506	1.4944	81.405	1.4994	83.277	1.5044	85.123
1.4845	77.619	1.4895	79.544	1.4945	81.442	1.4995	83.314	1.5045	85.159
1.4846	77.657	1.4896	79.582	1.4946	81.480	1.4996	83.351	1.5046	85.196
1.4847	77.696	1.4897	79.620	1.4947	81.518	1.4997	83.388	1.5047	85.233
1.4848	77.735	1.4898	79.659	1.4948	81.555	1.4998	83.425	1.5048	85.269
1.4849	77.774	1.4899	79.697	1.4949	81.593	1.4999	83.463	1.5049	85.306
1.4850	77.812	1.4900	79.735	1.4950	81.631	1.5000	83.500	1.5050	85.343
1.4851	77.851	1.4901	79.773	1.4951	81.668	1.5001	83.537	1.5051	85.379
1.4852	77.890	1.4902	79.811	1.4952	81.706	1.5002	83.574	1.5052	85.416
1.4853	77.928	1.4903	79.850	1.4953	81.744	1.5003	83.611	1.5053	85.452
1.4854	77.967	1.4904	79.888	1.4954	81.781	1.5004	83.648	1.5054	85.489
1.4855	78.006	1.4905	79.926	1.4965	81.819	1.5005	83.685	1.5055	85.525
1.4856	78.045	1.4906	79.964	1.4956	81.856	1.5006	83.722	1.5056	85.562
1.4857	78.083	1.4907	80.002	1.4957	81.894	1.5007	83.759	1.5057	85.598
1.4858	78.122	1.4908	80.040	1.4958	81.932	1.5008	83.796	1.5058	85.635
1.4859	78.160	1.4909	80.078	1.4959	81.969	1.5009	83.833	1.5059	85.672
1.4860	78.199	1.4910	80.116	1.4960	82.007	1.5010	83.870	1.5060	85.708
1.4861	78.238	1.4911	80.154	1.4961	82.044	1.5011	83.907	1.5061	85.744
1.4862	78.276	1.4912	80.192	1.4962	82.082	1.5012	83.944	1.5062	85.781
1.4863	78.315	1.4913	80.231	1.4963	82.119	1.5013	83.981	1.5063	85.817
1.4864	78.353	1.4914	80.269	1.4964	82.157	1.5014	84.018	1.5064	85.854
1.4865	78.392	1.4915	80.307	1.4965	82.194	1.5015	84.055	1.5065	85.890
1.4866	78.431	1.4916	80.345	1.4966	82.232	1.5016	84.092	1.5066	85.927
1.4867	78.469	1.4917	80.383	1.4967	82.269	1.5017	84.129	1.5067	85.963
1.4868	78.508	1.4918	80.421	1.4968	82.307	1.5018	84.166	1.5068	86.000
1.4869	78.546	1.4919	80.459	1.4969	82.344	1.5019	84.203	1.5069	86.036
1.4870	78.585	1.4920	80.497	1.4970	82.381	1.5020	84.240	1.5070	86.072
1.4871	78.623	1.4921	80.534	1.4971	82.419	1.5021	84.277	1.5071	86.109
1.4872	78.662	1.4922	80.572	1.4972	82.456	1.5022	84.314	1.5072	86.145
1.4873	78.700	1.4923	80.610	1.4973	82.494	1.5023	84.351	1.5073	86.182
1.4874	78.739	1.4924	80.648	1.4974	82.531	1.5024	84.388	1.5074	86.218
1.4975	78.777	1.4925	80.686	1.4975	82.569	1.5025	84.424	1.5075	86.254
1.4876	78.816	1.4926	80.724	1.4976	82.606	1.5026	84.461	1.5076	86.291
1.4877	78.854	1.4927	80.762	1.4977	82.643	1.5027	84.498	1.5077	86.327
1.4878	78.892	1.4928	80.800	1.4978	82.681	1.5028	84.535	1.5078	86.363
1.4879	78.931	1.4929	80.838	1.4979	82.718	1.5029	84.572	1.5079	86.399

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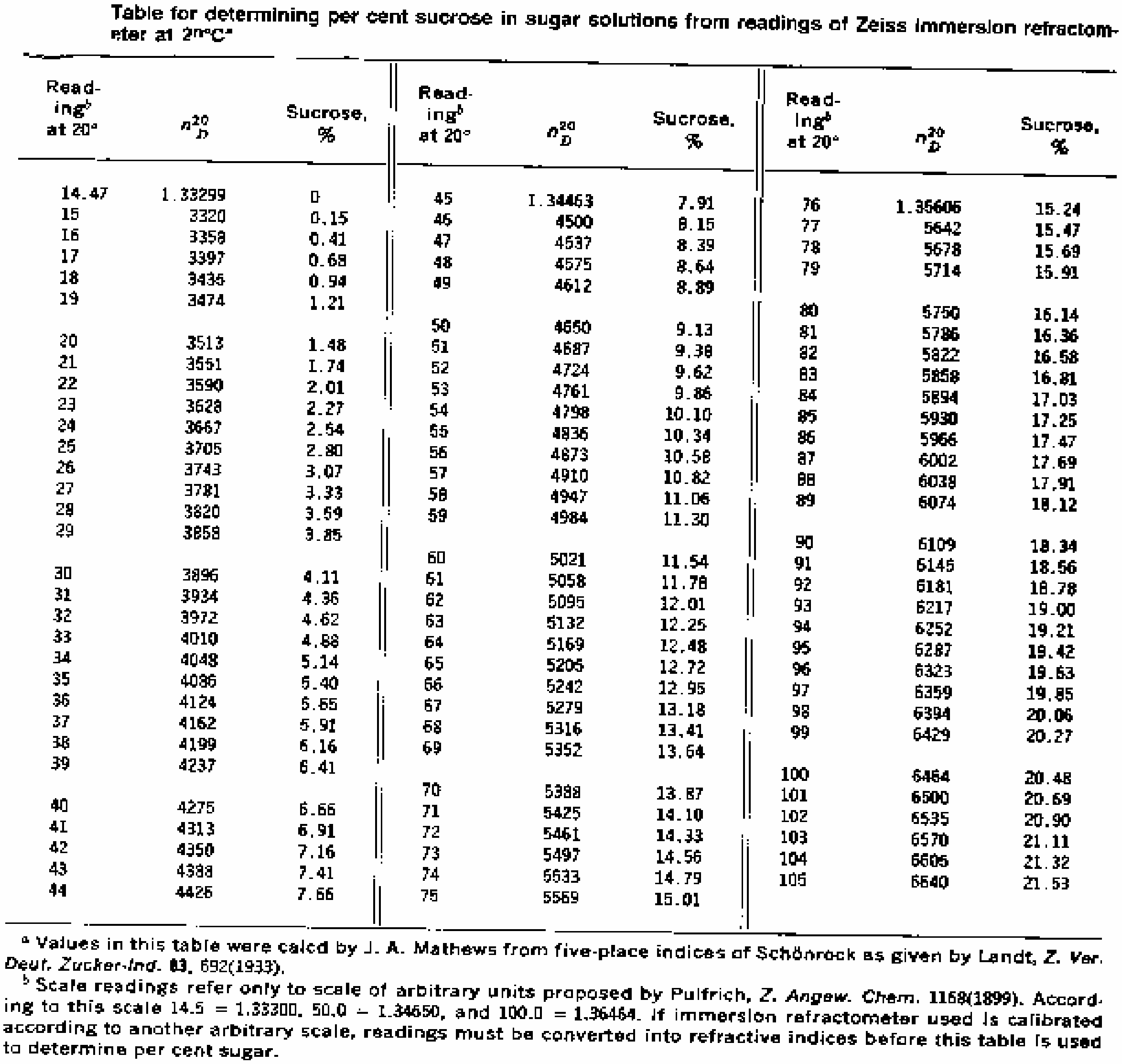

Table for determining per cent sucrose in sugar solutions from readings of Zeiss immersion refractometer at 20°C[a]

Reading[b] at 20°	n_D^{20}	Sucrose, %	Reading[b] at 20°	n_D^{20}	Sucrose, %	Reading[b] at 20°	n_D^{20}	Sucrose, %
14.47	1.33299	0	45	I.34463	7.91	76	1.35606	15.24
15	3320	0.15	46	4500	8.15	77	5642	15.47
16	3358	0.41	47	4537	8.39	78	5678	15.69
17	3397	0.68	48	4575	8.64	79	5714	15.91
18	3436	0.94	49	4612	8.89	80	5750	16.14
19	3474	1.21	50	4650	9.13	81	5786	16.36
20	3513	1.48	51	4687	9.38	82	5822	16.58
21	3551	I.74	52	4724	9.62	83	5858	16.81
22	3590	2.01	53	4761	9.86	84	5894	17.03
23	3628	2.27	54	4798	10.10	85	5930	17.25
24	3667	2.54	55	4836	10.34	86	5966	17.47
25	3705	2.80	56	4873	10.58	87	6002	17.69
26	3743	3.07	57	4910	10.82	88	6038	17.91
27	3781	3.33	58	4947	11.06	89	6074	18.12
28	3820	3.59	59	4984	11.30	90	6109	18.34
29	3858	3.85	60	5021	11.54	91	6145	18.56
30	3896	4.11	61	5058	11.78	92	6181	18.78
31	3934	4.36	62	5095	12.01	93	6217	19.00
32	3972	4.62	63	5132	12.25	94	6252	19.21
33	4010	4.88	64	5169	12.48	95	6287	19.42
34	4048	5.14	65	5206	12.72	96	6323	19.63
35	4086	5.40	66	5242	12.95	97	6359	19.85
36	4124	5.65	67	5279	13.18	98	6394	20.06
37	4162	5.91	68	5316	13.41	99	6429	20.27
38	4199	6.16	69	5352	13.64	100	6464	20.48
39	4237	6.41	70	5388	13.87	101	6500	20.69
40	4275	6.66	71	5425	14.10	102	6535	20.90
41	4313	6.91	72	5461	14.33	103	6570	21.11
42	4350	7.16	73	5497	14.56	104	6605	21.32
43	4388	7.41	74	5533	14.79	105	6640	21.53
44	4426	7.66	75	5569	15.01			

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[a] Values in this table were calcd by J. A. Mathews from five-place indices of Schönrock as given by Landt, *Z. Ver. Deut. Zucker-Ind.* **83**, 692(1933).

[b] Scale readings refer only to scale of arbitrary units proposed by Pulfrich, *Z. Angew. Chem.* **1168**(1899). According to this scale 14.5 = 1.33300, 50.0 = 1.34650, and 100.0 = 1.36464. If immersion refractometer used is calibrated according to another arbitrary scale, readings must be converted into refractive indices before this table is used to determine per cent sugar.

Annex H
(normative)

Density values of pure sucrose solutions at 20°C

w = mass fraction as a percentage, ρ = density in kg/m³, m_w/V = weight in air per unit volume in kg/m³, c = mass concentration in g/cm³. The density ρ has been calculated iteratively for mass fractions at 0.1% intervals using polynomial (1) and the relationship $c = w \times \rho\ (w,\ 20°C)$. The values for m_w/V were calculated: m_w/V = $(\rho-1.2)/0.99985$. The values $w > 60\%$: extrapolated range

w %	ρ kg/m³	m_w/V kg/m³	c g/cm³
0.0	998.203	997.153	0.000000
0.1	998.588	997.538	0.000999
0.2	998.974	997.924	0.001998
0.3	999.360	998.310	0.002998
0.4	999.746	998.696	0.003999
0.5	1000.132	999.082	0.005001
0.6	1000.519	999.469	0.006003
0.7	1000.906	999.856	0.007006
0.8	1001.293	1000.243	0.008010
0.9	1001.681	1000.631	0.009015
1.0	1002.068	1001.018	0.010021
1.1	1002.456	1001.407	0.011027
1.2	1002.845	1001.795	0.012034
1.3	1003.233	1002.184	0.013042
1.4	1003.622	1002.572	0.014051
1.5	1004.011	1002.962	0.015060
1.6	1004.401	1003.351	0.016070
1.7	1004.790	1003.741	0.017081
1.8	1005.180	1004.131	0.018093
1.9	1005.570	1004.521	0.019106
2.0	1005.961	1004.912	0.020119
2.1	1006.352	1005.302	0.021133
2.2	1006.743	1005.693	0.022148
2.3	1007.134	1006.085	0.023164
2.4	1007.526	1006.477	0.024181
2.5	1007.917	1006.868	0.025198
2.6	1008.310	1007.261	0.026216
2.7	1008.702	1007.653	0.027235
2.8	1009.095	1008.046	0.028255
2.9	1009.488	1008.439	0.029275
3.0	1009.881	1008.832	0.030296
3.1	1010.274	1009.226	0.031319
3.2	1010.668	1009.620	0.032341
3.3	1011.062	1010.014	0.033365
3.4	1011.457	1010.408	0.034390
3.5	1011.851	1010.803	0.035415
3.6	1012.246	1011.198	0.036441
3.7	1012.642	1011.593	0.037468
3.8	1013.037	1011.989	0.038495
3.9	1013.433	1012.385	0.039524
4.0	1013.829	1012.781	0.040553
4.1	1014.225	1013.177	0.041583
4.2	1014.622	1013.574	0.042614
4.3	1015.019	1013.971	0.043646
4.4	1015.416	1014.368	0.044678
4.5	1015.813	1014.766	0.045712
4.6	1016.211	1015.163	0.046746
4.7	1016.609	1015.561	0.047781
4.8	1017.007	1015.960	0.048816
4.9	1017.406	1016.359	0.049853
5.0	1017.805	1016.757	0.050890
5.1	1018.204	1017.157	0.051928
5.2	1018.604	1017.556	0.052967
5.3	1019.003	1017.956	0.054007
5.4	1019.403	1018.356	0.055048
5.5	1019.804	1018.756	0.056089
5.6	1020.204	1019.157	0.057131
5.7	1020.605	1019.558	0.058174
5.8	1021.006	1019.959	0.059218
5.9	1021.408	1020.361	0.060263
6.0	1021.809	1020.762	0.061309
6.1	1022.211	1021.164	0.062355
6.2	1022.614	1021.567	0.063402
6.3	1023.016	1021.969	0.064450
6.4	1023.419	1022.372	0.065499
6.5	1023.822	1022.775	0.066548
6.6	1024.226	1023.179	0.067599
6.7	1024.629	1023.583	0.068650
6.8	1025.033	1023.987	0.069702
6.9	1025.438	1024.391	0.070755
7.0	1025.842	1024.796	0.071809
7.1	1026.247	1025.201	0.072864
7.2	1026.652	1025.606	0.073919
7.3	1027.058	1026.011	0.074975
7.4	1027.463	1026.417	0.076032
7.5	1027.869	1026.823	0.077090
7.6	1028.276	1027.230	0.078149
7.7	1028.682	1027.636	0.079209
7.8	1029.089	1028.043	0.080269
7.9	1029.496	1028.451	0.081330
8.0	1029.904	1028.858	0.082392
8.1	1030.311	1029.266	0.083455
8.2	1030.720	1029.674	0.084519
8.3	1031.128	1030.082	0.085584
8.4	1031.536	1030.491	0.086649
8.5	1031.945	1030.900	0.087715
8.6	1032.355	1031.309	0.088782
8.7	1032.764	1031.719	0.089850
8.8	1033.174	1032.129	0.090919
8.9	1033.584	1032.539	0.091989
9.0	1033.994	1032.949	0.093059
9.1	1034.405	1033.360	0.094131
9.2	1034.816	1033.771	0.095203
9.3	1035.227	1034.182	0.096276
9.4	1035.639	1034.594	0.097350
9.5	1036.051	1035.006	0.098425
9.6	1036.463	1035.418	0.099500
9.7	1036.875	1035.831	0.100577
9.8	1037.288	1036.243	0.101654
9.9	1037.701	1036.656	0.102732
10.0	1038.114	1037.070	0.103811
10.1	1038.528	1037.483	0.104891
10.2	1038.942	1037.897	0.105972
10.3	1039.356	1038.312	0.107054
10.4	1039.770	1038.726	0.108136
10.5	1040.185	1039.141	0.109219
10.6	1040.600	1039.556	0.110304
10.7	1041.016	1039.972	0.111389
10.8	1041.431	1040.387	0.112475
10.9	1041.847	1040.804	0.113561
11.0	1042.264	1041.220	0.114649
11.1	1042.680	1041.636	0.115738
11.2	1043.097	1042.053	0.116827
11.3	1043.514	1042.471	0.117917
11.4	1043.932	1042.888	0.119008
11.5	1044.350	1043.306	0.120100
11.6	1044.768	1043.724	0.121193
11.7	1045.186	1044.143	0.122287
11.8	1045.605	1044.561	0.123381
11.9	1046.024	1044.980	0.124477
12.0	1046.443	1045.400	0.125573
12.1	1046.862	1045.819	0.126670
12.2	1047.282	1046.239	0.127768
12.3	1047.702	1046.659	0.128867
12.4	1048.123	1047.080	0.129967
12.5	1048.544	1047.501	0.131068
12.6	1048.965	1047.922	0.132170
12.7	1049.386	1048.343	0.133272
12.8	1049.808	1048.765	0.134375
12.9	1050.230	1049.187	0.135480
13.0	1050.652	1049.609	0.136585
13.1	1051.075	1050.032	0.137691
13.2	1051.497	1050.455	0.138798
13.3	1051.921	1050.878	0.139905
13.4	1052.344	1051.302	0.141014
13.5	1052.768	1051.726	0.142124
13.6	1053.192	1052.150	0.143234
13.7	1053.616	1052.574	0.144345
13.8	1054.041	1052.999	0.145458
13.9	1054.466	1053.424	0.146571
14.0	1054.891	1053.849	0.147685
14.1	1055.317	1054.275	0.148800
14.2	1055.743	1054.701	0.149915
14.3	1056.169	1055.127	0.151032
14.4	1056.596	1055.554	0.152150
14.5	1057.022	1055.981	0.153268
14.6	1057.450	1056.408	0.154388
14.7	1057.877	1056.835	0.155508
14.8	1058.305	1057.263	0.156629
14.9	1058.733	1057.691	0.157751

Table A (continued)

w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3	w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3	w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3
15.0	1059.161	1058.120	0.158874	20.0	1080.976	1079.938	0.216195	25.0	1103.589	1102.555	0.275897
15.1	1059.590	1058.549	0.159998	20.1	1081.420	1080.382	0.217365	25.1	1104.050	1103.015	0.277116
15.2	1060.019	1058.978	0.161123	20.2	1081.865	1080.827	0.218537	25.2	1104.511	1103.476	0.278337
15.3	1060.448	1059.407	0.162249	20.3	1082.310	1081.272	0.219709	25.3	1104.972	1103.938	0.279558
15.4	1060.878	1059.837	0.163375	20.4	1082.755	1081.717	0.220882	25.4	1105.434	1104.399	0.280780
15.5	1061.308	1060.267	0.164503	20.5	1083.201	1082.163	0.222056	25.5	1105.896	1104.861	0.282003
15.6	1061.738	1060.697	0.165631	20.6	1083.647	1082.609	0.223231	25.6	1106.358	1105.324	0.283228
15.7	1062.168	1061.127	0.166760	20.7	1084.093	1083.055	0.224407	25.7	1106.820	1105.786	0.284453
15.8	1062.599	1061.558	0.167891	20.8	1084.540	1083.502	0.225584	25.8	1107.283	1106.249	0.285679
15.9	1063.030	1061.990	0.169022	20.9	1084.986	1083.949	0.226762	25.9	1107.747	1106.713	0.286906
16.0	1063.462	1062.421	0.170154	21.0	1085.434	1084.396	0.227941	26.0	1108.210	1107.176	0.288135
16.1	1063.893	1062.853	0.171287	21.1	1085.881	1084.844	0.229121	26.1	1108.674	1107.640	0.289364
16.2	1064.325	1063.285	0.172421	21.2	1086.329	1085.292	0.230302	26.2	1109.138	1108.105	0.290594
16.3	1064.758	1063.717	0.173556	21.3	1086.777	1085.740	0.231484	26.3	1109.603	1108.569	0.291826
16.4	1065.191	1064.150	0.174691	21.4	1087.226	1086.189	0.232666	26.4	1110.068	1109.034	0.293058
16.5	1065.624	1064.583	0.175828	21.5	1087.675	1086.638	0.233850	26.5	1110.533	1109.500	0.294291
16.6	1066.057	1065.017	0.176965	21.6	1088.124	1087.087	0.235035	26.6	1110.999	1109.965	0.295526
16.7	1066.490	1065.450	0.178104	21.7	1088.573	1087.536	0.236220	26.7	1111.465	1110.431	0.296761
16.8	1066.924	1065.884	0.179243	21.8	1089.023	1087.986	0.237407	26.8	1111.931	1110.898	0.297998
16.9	1067.359	1066.319	0.180384	21.9	1089.473	1088.436	0.238595	26.9	1112.398	1111.365	0.299235
17.0	1067.793	1066.753	0.181525	22.0	1089.924	1088.887	0.239783	27.0	1112.865	1111.832	0.300473
17.1	1068.228	1067.188	0.182667	22.1	1090.374	1089.338	0.240973	27.1	1113.332	1112.299	0.301713
17.2	1068.663	1067.623	0.183810	22.2	1090.826	1089.789	0.242163	27.2	1113.800	1112.767	0.302954
17.3	1069.099	1068.059	0.184954	22.3	1091.277	1090.241	0.243355	27.3	1114.268	1113.235	0.304195
17.4	1069.535	1068.495	0.186099	22.4	1091.729	1090.692	0.244547	27.4	1114.736	1113.703	0.305438
17.5	1069.971	1068.931	0.187245	22.5	1092.181	1091.144	0.245741	27.5	1115.205	1114.172	0.306681
17.6	1070.407	1069.367	0.188392	22.6	1092.633	1091.597	0.246935	27.6	1115.674	1114.641	0.307926
17.7	1070.844	1069.804	0.189539	22.7	1093.086	1092.050	0.248131	27.7	1116.143	1115.110	0.309172
17.8	1071.281	1070.241	0.190688	22.8	1093.539	1092.503	0.249327	27.8	1116.613	1115.580	0.310418
17.9	1071.718	1070.679	0.191838	22.9	1093.992	1092.956	0.250524	27.9	1117.083	1116.050	0.311666
18.0	1072.156	1071.117	0.192988	23.0	1094.446	1093.410	0.251723	28.0	1117.553	1116.520	0.312915
18.1	1072.594	1071.555	0.194139	23.1	1094.900	1093.864	0.252922	28.1	1118.024	1116.991	0.314165
18.2	1073.032	1071.993	0.195292	23.2	1095.354	1094.319	0.254122	28.2	1118.495	1117.462	0.315415
18.3	1073.471	1072.432	0.196445	23.3	1095.809	1094.773	0.255324	28.3	1118.966	1117.934	0.316667
18.4	1073.910	1072.871	0.197599	23.4	1096.264	1095.228	0.256526	28.4	1119.438	1118.405	0.317920
18.5	1074.349	1073.310	0.198755	23.5	1096.720	1095.684	0.257729	28.5	1119.910	1118.878	0.319174
18.6	1074.789	1073.750	0.199911	23.6	1097.175	1096.140	0.258933	28.6	1120.382	1119.350	0.320429
18.7	1075.228	1074.190	0.201068	23.7	1097.631	1096.596	0.260139	28.7	1120.855	1119.823	0.321685
18.8	1075.669	1074.630	0.202226	23.8	1098.088	1097.052	0.261345	28.8	1121.328	1120.296	0.322942
18.9	1076.109	1075.070	0.203385	23.9	1098.544	1097.509	0.262552	28.9	1121.801	1120.769	0.324201
19.0	1076.550	1075.511	0.204545	24.0	1099.001	1097.966	0.263760	29.0	1122.275	1121.243	0.325460
19.1	1076.991	1075.953	0.205705	24.1	1099.458	1098.423	0.264969	29.1	1122.749	1121.717	0.326720
19.2	1077.433	1076.394	0.206867	24.2	1099.916	1098.881	0.266180	29.2	1123.223	1122.192	0.327981
19.3	1077.874	1076.836	0.208030	24.3	1100.374	1099.339	0.267391	29.3	1123.698	1122.667	0.329244
19.4	1078.317	1077.278	0.209193	24.4	1100.832	1099.797	0.268603	29.4	1124.173	1123.142	0.330507
19.5	1078.759	1077.721	0.210358	24.5	1101.291	1100.256	0.269816	29.5	1124.649	1123.617	0.331771
19.6	1079.202	1078.163	0.211524	24.6	1101.750	1100.715	0.271030	29.6	1125.125	1124.093	0.333037
19.7	1079.645	1078.607	0.212690	24.7	1102.209	1101.174	0.272246	29.7	1125.601	1124.569	0.334303
19.8	1080.088	1079.050	0.213857	24.8	1102.669	1101.634	0.273462	29.8	1126.077	1125.046	0.335571
19.9	1080.532	1079.494	0.215026	24.9	1103.129	1102.094	0.274679	29.9	1126.554	1125.523	0.336840

Table A (continued)

w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3	w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3	w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3
30.0	1127.031	1126.000	0.338109	35.0	1151.331	1150.304	0.402966	40.0	1176.518	1175.495	0.470607
30.1	1127.509	1126.478	0.339380	35.1	1151.826	1150.799	0.404291	40.1	1177.031	1176.008	0.471990
30.2	1127.986	1126.955	0.340652	35.2	1152.322	1151.294	0.405617	40.2	1177.545	1176.521	0.473373
30.3	1128.465	1127.434	0.341925	35.3	1152.817	1151.790	0.406945	40.3	1178.058	1177.035	0.474758
30.4	1128.943	1127.912	0.343199	35.4	1153.313	1152.286	0.408273	40.4	1178.573	1177.549	0.476143
30.5	1129.422	1128.391	0.344474	35.5	1153.810	1152.783	0.409602	40.5	1179.087	1178.064	0.477530
30.6	1129.901	1128.871	0.345750	35.6	1154.306	1153.279	0.410933	40.6	1179.602	1178.579	0.478918
30.7	1130.381	1129.350	0.347027	35.7	1154.804	1153.777	0.412265	40.7	1180.117	1179.094	0.480308
30.8	1130.861	1129.830	0.348305	35.8	1155.301	1154.274	0.413598	40.8	1180.632	1179.609	0.481698
30.9	1131.341	1130.311	0.349584	35.9	1155.799	1154.772	0.414932	40.9	1181.148	1180.125	0.483090
31.0	1131.822	1130.791	0.350865	36.0	1156.297	1155.270	0.416267	41.0	1181.665	1180.642	0.484483
31.1	1132.302	1131.272	0.352146	36.1	1156.796	1155.769	0.417603	41.1	1182.181	1181.158	0.485877
31.2	1132.784	1131.754	0.353429	36.2	1157.294	1156.268	0.418941	41.2	1182.698	1181.676	0.487272
31.3	1133.265	1132.235	0.354712	36.3	1157.794	1156.767	0.420279	41.3	1183.216	1182.193	0.488668
31.4	1133.747	1132.717	0.355997	36.4	1158.293	1157.267	0.421619	41.4	1183.733	1182.711	0.490066
31.5	1134.230	1133.200	0.357282	36.5	1158.793	1157.767	0.422960	41.5	1184.252	1183.229	0.491464
31.6	1134.712	1133.682	0.358569	36.6	1159.293	1158.267	0.424301	41.6	1184.770	1183.748	0.492864
31.7	1135.195	1134.166	0.359857	36.7	1159.794	1158.768	0.425644	41.7	1185.289	1184.266	0.494265
31.8	1135.679	1134.649	0.361146	36.8	1160.295	1159.269	0.426989	41.8	1185.808	1184.786	0.495668
31.9	1136.163	1135.133	0.362436	36.9	1160.797	1159.771	0.428334	41.9	1186.328	1185.305	0.497071
32.0	1136.647	1135.617	0.363727	37.0	1161.298	1160.272	0.429680	42.0	1186.848	1185.825	0.498476
32.1	1137.131	1136.101	0.365019	37.1	1161.800	1160.775	0.431028	42.1	1187.368	1186.346	0.499882
32.2	1137.616	1136.586	0.366312	37.2	1162.303	1161.277	0.432377	42.2	1187.889	1186.867	0.501289
32.3	1138.101	1137.071	0.367607	37.3	1162.806	1161.780	0.433727	42.3	1188.410	1187.388	0.502697
32.4	1138.586	1137.557	0.368902	37.4	1163.309	1162.283	0.435078	42.4	1188.931	1187.909	0.504107
32.5	1139.072	1138.043	0.370198	37.5	1163.812	1162.787	0.436430	42.5	1189.453	1188.431	0.505517
32.6	1139.558	1138.529	0.371496	37.6	1164.316	1163.291	0.437783	42.6	1189.975	1188.953	0.506929
32.7	1140.045	1139.016	0.372795	37.7	1164.821	1163.795	0.439137	42.7	1190.498	1189.476	0.508342
32.8	1140.532	1139.503	0.374094	37.8	1165.325	1164.300	0.440493	42.8	1191.021	1189.999	0.509757
32.9	1141.019	1139.990	0.375395	37.9	1165.830	1164.805	0.441850	42.9	1191.544	1190.522	0.511172
33.0	1141.506	1140.477	0.376697	38.0	1166.335	1165.310	0.443207	43.0	1192.067	1191.046	0.512589
33.1	1141.994	1140.965	0.378000	38.1	1166.841	1165.816	0.444566	43.1	1192.591	1191.570	0.514007
33.2	1142.483	1141.454	0.379304	38.2	1167.347	1166.322	0.445927	43.2	1193.116	1192.095	0.515426
33.3	1142.971	1141.942	0.380609	38.3	1167.854	1166.829	0.447288	43.3	1193.641	1192.620	0.516846
33.4	1143.460	1142.432	0.381916	38.4	1168.360	1167.336	0.448650	43.4	1194.166	1193.145	0.518268
33.5	1143.949	1142.921	0.383223	38.5	1168.868	1167.843	0.450014	43.5	1194.691	1193.670	0.519691
33.6	1144.439	1143.411	0.384532	38.6	1169.375	1168.350	0.451379	43.6	1195.217	1194.196	0.521115
33.7	1144.929	1143.901	0.385841	38.7	1169.883	1168.858	0.452745	43.7	1195.743	1194.723	0.522540
33.8	1145.420	1144.391	0.387152	38.8	1170.391	1169.367	0.454112	43.8	1196.270	1195.249	0.523966
33.9	1145.910	1144.882	0.388464	38.9	1170.900	1169.875	0.455480	43.9	1196.797	1195.776	0.525394
34.0	1146.401	1145.373	0.389776	39.0	1171.409	1170.384	0.456849	44.0	1197.324	1196.304	0.526823
34.1	1146.893	1145.865	0.391090	39.1	1171.918	1170.894	0.458220	44.1	1197.852	1196.832	0.528253
34.2	1147.384	1146.356	0.392405	39.2	1172.428	1171.404	0.459592	44.2	1198.380	1197.360	0.529684
34.3	1147.877	1146.849	0.393722	39.3	1172.938	1171.914	0.460965	44.3	1198.909	1197.888	0.531117
34.4	1148.369	1147.341	0.395039	39.4	1173.448	1172.424	0.462339	44.4	1199.438	1198.417	0.532550
34.5	1148.862	1147.834	0.396357	39.5	1173.959	1172.935	0.463714	44.5	1199.967	1198.947	0.533985
34.6	1149.355	1148.327	0.397677	39.6	1174.470	1173.446	0.465090	44.6	1200.496	1199.476	0.535421
34.7	1149.849	1148.821	0.398997	39.7	1174.982	1173.958	0.466468	44.7	1201.026	1200.006	0.536859
34.8	1150.343	1149.315	0.400319	39.8	1175.494	1174.470	0.467846	44.8	1201.557	1200.537	0.538297
34.9	1150.837	1149.809	0.401642	39.9	1176.006	1174.982	0.469226	44.9	1202.088	1201.068	0.539737

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Table A (continued)

w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3
45.0	1202.619	1201.599	0.541178
45.1	1203.150	1202.130	0.542621
45.2	1203.682	1202.662	0.544064
45.3	1204.214	1203.195	0.545509
45.4	1204.747	1203.727	0.546955
45.5	1205.280	1204.261	0.548402
45.6	1205.813	1204.794	0.549851
45.7	1206.347	1205.328	0.551301
45.8	1206.881	1205.862	0.552752
45.9	1207.416	1206.397	0.554204
46.0	1207.950	1206.931	0.555657
46.1	1208.486	1207.467	0.557112
46.2	1209.021	1208.003	0.558568
46.3	1209.557	1208.539	0.560025
46.4	1210.094	1209.075	0.561483
46.5	1210.630	1209.612	0.562943
46.6	1211.168	1210.149	0.564404
46.7	1211.705	1210.687	0.565866
46.8	1212.243	1211.225	0.567330
46.9	1212.781	1211.763	0.568794
47.0	1213.320	1212.302	0.570260
47.1	1213.859	1212.841	0.571728
47.2	1214.398	1213.380	0.573196
47.3	1214.938	1213.920	0.574666
47.4	1215.478	1214.460	0.576137
47.5	1216.019	1215.001	0.577609
47.6	1216.560	1215.542	0.579082
47.7	1217.101	1216.083	0.580557
47.8	1217.643	1216.625	0.582033
47.9	1218.185	1217.167	0.583510
48.0	1218.727	1217.710	0.584989
48.1	1219.270	1218.253	0.586469
48.2	1219.813	1218.796	0.587950
48.3	1220.357	1219.340	0.589432
48.4	1220.901	1219.884	0.590916
48.5	1221.445	1220.428	0.592401
48.6	1221.990	1220.973	0.593887
48.7	1222.535	1221.518	0.595374
48.8	1223.080	1222.064	0.596863
48.9	1223.626	1222.609	0.598353
49.0	1224.172	1223.156	0.599844
49.1	1224.719	1223.702	0.601337
49.2	1225.266	1224.250	0.602831
49.3	1225.813	1224.797	0.604326
49.4	1226.361	1225.345	0.605822
49.5	1226.909	1225.893	0.607320
49.6	1227.458	1226.442	0.608819
49.7	1228.007	1226.991	0.610319
49.8	1228.556	1227.540	0.611821
49.9	1229.106	1228.090	0.613324
50.0	1229.656	1228.640	0.614828
50.1	1230.206	1229.190	0.616333
50.2	1230.757	1229.741	0.617840
50.3	1231.308	1230.293	0.619348
50.4	1231.860	1230.844	0.620857
50.5	1232.412	1231.396	0.622368
50.6	1232.964	1231.949	0.623880
50.7	1233.517	1232.502	0.625393
50.8	1234.070	1233.055	0.626907
50.9	1234.623	1233.608	0.628423
51.0	1235.177	1234.162	0.629940
51.1	1235.732	1234.717	0.631459
51.2	1236.286	1235.271	0.632979
51.3	1236.841	1235.827	0.634500
51.4	1237.397	1236.382	0.636022
51.5	1237.952	1236.938	0.637546
51.6	1238.509	1237.494	0.639070
51.7	1239.065	1238.051	0.640597
51.8	1239.622	1238.608	0.642124
51.9	1240.180	1239.165	0.643653
52.0	1240.737	1239.723	0.645183
52.1	1241.295	1240.281	0.646715
52.2	1241.854	1240.840	0.648248
52.3	1242.413	1241.399	0.649782
52.4	1242.972	1241.958	0.651317
52.5	1243.532	1242.518	0.652854
52.6	1244.092	1243.078	0.654392
52.7	1244.652	1243.639	0.655932
52.8	1245.213	1244.200	0.657472
52.9	1245.774	1244.761	0.659015
53.0	1246.336	1245.323	0.660558
53.1	1246.898	1245.885	0.662103
53.2	1247.460	1246.447	0.663649
53.3	1248.023	1247.010	0.665196
53.4	1248.586	1247.573	0.666745
53.5	1249.150	1248.137	0.668295
53.6	1249.713	1248.701	0.669846
53.7	1250.278	1249.265	0.671399
53.8	1250.842	1249.830	0.672953
53.9	1251.408	1250.395	0.674509
54.0	1251.973	1250.961	0.676065
54.1	1252.539	1251.527	0.677624
54.2	1253.105	1252.093	0.679183
54.3	1253.672	1252.660	0.680744
54.4	1254.239	1253.227	0.682306
54.5	1254.806	1253.794	0.683869
54.6	1255.374	1254.362	0.685434
54.7	1255.942	1254.930	0.687000
54.8	1256.511	1255.499	0.688568
54.9	1257.080	1256.068	0.690137
55.0	1257.649	1256.637	0.691707
55.1	1258.219	1257.207	0.693279
55.2	1258.789	1257.778	0.694851
55.3	1259.359	1258.348	0.696426
55.4	1259.930	1258.919	0.698001
55.5	1260.502	1259.490	0.699578
55.6	1261.073	1260.062	0.701157
55.7	1261.645	1260.634	0.702736
55.8	1262.218	1261.207	0.704317
55.9	1262.791	1261.780	0.705900
56.0	1263.364	1262.353	0.707484
56.1	1263.937	1262.927	0.709069
56.2	1264.511	1263.501	0.710655
56.3	1265.086	1264.075	0.712243
56.4	1265.661	1264.650	0.713833
56.5	1266.236	1265.226	0.715423
56.6	1266.811	1265.801	0.717015
56.7	1267.387	1266.377	0.718609
56.8	1267.964	1266.954	0.720203
56.9	1268.540	1267.531	0.721800
57.0	1269.118	1268.108	0.723397
57.1	1269.695	1268.685	0.724996
57.2	1270.273	1269.263	0.726596
57.3	1270.851	1269.842	0.728198
57.4	1271.430	1270.421	0.729801
57.5	1272.009	1271.000	0.731405
57.6	1272.589	1271.579	0.733011
57.7	1273.168	1272.159	0.734618
57.8	1273.749	1272.740	0.736227
57.9	1274.329	1273.320	0.737837
58.0	1274.910	1273.901	0.739448
58.1	1275.492	1274.483	0.741061
58.2	1276.074	1275.065	0.742675
58.3	1276.656	1275.647	0.744290
58.4	1277.238	1276.230	0.745907
58.5	1277.821	1276.813	0.747526
58.6	1278.405	1277.396	0.749145
58.7	1278.989	1277.980	0.750766
58.8	1279.573	1278.565	0.752389
58.9	1280.157	1279.149	0.754013
59.0	1280.742	1279.734	0.755638
59.1	1281.328	1280.320	0.757265
59.2	1281.913	1280.905	0.758893
59.3	1282.499	1281.492	0.760522
59.4	1283.086	1282.078	0.762153
59.5	1283.673	1282.665	0.763785
59.6	1284.260	1283.253	0.765419
59.7	1284.848	1283.840	0.767054
59.8	1285.436	1284.429	0.768691
59.9	1286.024	1285.017	0.770329

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Table A (continued)

w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3	w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3	w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3
60.0	1286.61	1285.61	0.77197	65.0	1316.56	1315.55	0.85576	70.0	1347.48	1346.48	0.94323
60.1	1287.20	1286.20	0.77361	65.1	1317.17	1316.16	0.85747	70.1	1348.11	1347.11	0.94502
60.2	1287.79	1286.79	0.77525	65.2	1317.77	1316.77	0.85919	70.2	1348.73	1347.74	0.94681
60.3	1288.38	1287.38	0.77689	65.3	1318.38	1317.38	0.86090	70.3	1349.36	1348.37	0.94860
60.4	1288.97	1287.97	0.77854	65.4	1318.99	1317.99	0.86262	70.4	1349.99	1349.00	0.95040
60.5	1289.56	1288.56	0.78019	65.5	1319.60	1318.60	0.86434	70.5	1350.62	1349.63	0.95219
60.6	1290.15	1289.15	0.78183	65.6	1320.22	1319.21	0.86606	70.6	1351.25	1350.26	0.95398
60.7	1290.75	1289.74	0.78348	65.7	1320.83	1319.82	0.86778	70.7	1351.88	1350.89	0.95578
60.8	1291.34	1290.33	0.78513	65.8	1321.44	1320.44	0.86951	70.8	1352.52	1351.52	0.95758
60.9	1291.93	1290.92	0.78679	65.9	1322.05	1321.05	0.87123	70.9	1353.15	1352.15	0.95938
61.0	1292.52	1291.52	0.78844	66.0	1322.66	1321.66	0.87296	71.0	1353.78	1352.78	0.96118
61.1	1293.12	1292.11	0.79009	66.1	1323.28	1322.27	0.87468	71.1	1354.41	1353.41	0.96299
61.2	1293.71	1292.70	0.79175	66.2	1323.89	1322.89	0.87641	71.2	1355.04	1354.05	0.96479
61.3	1294.30	1293.30	0.79341	66.3	1324.50	1323.50	0.87814	71.3	1355.68	1354.68	0.96660
61.4	1294.90	1293.89	0.79507	66.4	1325.12	1324.11	0.87988	71.4	1356.31	1355.31	0.96841
61.5	1295.49	1294.49	0.79673	66.5	1325.73	1324.73	0.88161	71.5	1356.94	1355.95	0.97021
61.6	1296.09	1295.08	0.79839	66.6	1326.34	1325.34	0.88335	71.6	1357.58	1356.58	0.97203
61.7	1296.68	1295.68	0.80005	66.7	1326.96	1325.96	0.88508	71.7	1358.21	1357.22	0.97384
61.8	1297.28	1296.27	0.80172	66.8	1327.58	1326.57	0.88682	71.8	1358.85	1357.85	0.97565
61.9	1297.88	1296.87	0.80339	66.9	1328.19	1327.19	0.88856	71.9	1359.48	1358.49	0.97747
62.0	1298.47	1297.47	0.80505	67.0	1328.81	1327.81	0.89030	72.0	1360.12	1359.12	0.97928
62.1	1299.07	1298.06	0.80672	67.1	1329.42	1328.42	0.89204	72.1	1360.75	1359.76	0.98110
62.2	1299.67	1298.66	0.80839	67.2	1330.04	1329.04	0.89379	72.2	1361.39	1360.39	0.98292
62.3	1300.27	1299.26	0.81007	67.3	1330.66	1329.66	0.89553	72.3	1362.03	1361.03	0.98475
62.4	1300.86	1299.86	0.81174	67.4	1331.28	1330.28	0.89728	72.4	1362.66	1361.67	0.98657
62.5	1301.46	1300.46	0.81341	67.5	1331.90	1330.89	0.89903	72.5	1363.30	1362.31	0.98839
62.6	1302.06	1301.06	0.81509	67.6	1332.51	1331.51	0.90078	72.6	1363.94	1362.94	0.99022
62.7	1302.66	1301.66	0.81677	67.7	1333.13	1332.13	0.90253	72.7	1364.58	1363.58	0.99205
62.8	1303.26	1302.26	0.81845	67.8	1333.75	1332.75	0.90428	72.8	1365.22	1364.22	0.99388
62.9	1303.86	1302.86	0.82013	67.9	1334.37	1333.37	0.90604	72.9	1365.86	1364.86	0.99571
63.0	1304.46	1303.46	0.82181	68.0	1334.99	1333.99	0.90779	73.0	1366.50	1365.50	0.99754
63.1	1305.06	1304.06	0.82349	68.1	1335.61	1334.61	0.90955	73.1	1367.14	1366.14	0.99938
63.2	1305.66	1304.66	0.82518	68.2	1336.23	1335.23	0.91131	73.2	1367.78	1366.78	1.00121
63.3	1306.27	1305.26	0.82687	68.3	1336.85	1335.86	0.91307	73.3	1368.42	1367.42	1.00305
63.4	1306.87	1305.86	0.82855	68.4	1337.48	1336.48	0.91483	73.4	1369.06	1368.06	1.00489
63.5	1307.47	1306.47	0.83024	68.5	1338.10	1337.10	0.91660	73.5	1369.70	1368.70	1.00673
63.6	1308.07	1307.07	0.83193	68.6	1338.72	1337.72	0.91836	73.6	1370.34	1369.35	1.00857
63.7	1308.68	1307.67	0.83363	68.7	1339.34	1338.35	0.92013	73.7	1370.98	1369.99	1.01041
63.8	1309.28	1308.28	0.83532	68.8	1339.97	1338.97	0.92190	73.8	1371.63	1370.63	1.01226
63.9	1309.88	1308.88	0.83702	68.9	1340.59	1339.59	0.92367	73.9	1372.27	1371.27	1.01411
64.0	1310.49	1309.49	0.83871	69.0	1341.22	1340.22	0.92544	74.0	1372.91	1371.92	1.01595
64.1	1311.09	1310.09	0.84041	69.1	1341.84	1340.84	0.92721	74.1	1373.56	1372.56	1.01780
64.2	1311.70	1310.70	0.84211	69.2	1342.46	1341.47	0.92899	74.2	1374.20	1373.21	1.01966
64.3	1312.31	1311.30	0.84381	69.3	1343.09	1342.09	0.93076	74.3	1374.84	1373.85	1.02151
64.4	1312.91	1311.91	0.84551	69.4	1343.72	1342.72	0.93254	74.4	1375.49	1374.50	1.02336
64.5	1313.52	1312.51	0.84722	69.5	1344.34	1343.34	0.93432	74.5	1376.13	1375.14	1.02522
64.6	1314.12	1313.12	0.84892	69.6	1344.97	1343.97	0.93610	74.6	1376.78	1375.79	1.02708
64.7	1314.73	1313.73	0.85063	69.7	1345.59	1344.60	0.93788	74.7	1377.43	1376.43	1.02894
64.8	1315.34	1314.34	0.85234	69.8	1346.22	1345.22	0.93966	74.8	1378.07	1377.08	1.03080
64.9	1315.95	1314.95	0.85405	69.9	1346.85	1345.85	0.94145	74.9	1378.72	1377.73	1.03266

Table A (continued)

w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3	w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3	w %	ρ kg/m^3	m_w/V kg/m^3	c g/cm^3
75.0	1379.37	1378.37	1.03452	80.0	1412.20	1411.21	1.12976	85.0	1445.94	1444.95	1.22905
75.1	1380.01	1379.02	1.03639	80.1	1412.86	1411.88	1.13170	85.1	1446.62	1445.64	1.23107
75.2	1380.66	1379.67	1.03826	80.2	1413.53	1412.54	1.13365	85.2	1447.30	1446.32	1.23310
75.3	1381.31	1380.32	1.04013	80.3	1414.20	1413.21	1.13560	85.3	1447.99	1447.00	1.23513
75.4	1381.96	1380.97	1.04200	80.4	1414.86	1413.88	1.13755	85.4	1448.67	1447.69	1.23717
75.5	1382.61	1381.61	1.04387	80.5	1415.53	1414.54	1.13950	85.5	1449.36	1448.37	1.23920
75.6	1383.26	1382.26	1.04574	80.6	1416.20	1415.21	1.14146	85.6	1450.04	1449.06	1.24124
75.7	1383.91	1382.91	1.04762	80.7	1416.87	1415.88	1.14341	85.7	1450.73	1449.75	1.24327
75.8	1384.56	1383.56	1.04949	80.8	1417.54	1416.55	1.14537	85.8	1451.41	1450.43	1.24531
75.9	1385.21	1384.21	1.05137	80.9	1418.21	1417.22	1.14733	85.9	1452.10	1451.12	1.24735
76.0	1385.86	1384.87	1.05325	81.0	1418.87	1417.89	1.14929	86.0	1452.79	1451.80	1.24940
76.1	1386.51	1385.52	1.05513	81.1	1419.54	1418.56	1.15125	86.1	1453.47	1452.49	1.25144
76.2	1387.16	1386.17	1.05702	81.2	1420.21	1419.23	1.15321	86.2	1454.16	1453.18	1.25349
76.3	1387.81	1386.82	1.05890	81.3	1420.88	1419.90	1.15518	86.3	1454.85	1453.87	1.25553
76.4	1388.47	1387.47	1.06079	81.4	1421.56	1420.57	1.15715	86.4	1455.54	1454.56	1.25758
76.5	1389.12	1388.13	1.06268	81.5	1422.23	1421.24	1.15911	86.5	1456.23	1455.24	1.25963
76.6	1389.77	1388.78	1.06456	81.6	1422.90	1421.91	1.16108	86.6	1456.91	1455.93	1.26169
76.7	1390.42	1389.43	1.06646	81.7	1423.57	1422.58	1.16306	86.7	1457.60	1456.62	1.26374
76.8	1391.08	1390.09	1.06835	81.8	1424.24	1423.26	1.16503	86.8	1458.29	1457.31	1.26580
76.9	1391.73	1390.74	1.07024	81.9	1424.91	1423.93	1.16700	86.9	1458.98	1458.00	1.26786
77.0	1392.39	1391.40	1.07214	82.0	1425.59	1424.60	1.16898	87.0	1459.67	1458.69	1.26991
77.1	1393.04	1392.05	1.07404	82.1	1426.26	1425.27	1.17096	87.1	1460.36	1459.38	1.27198
77.2	1393.70	1392.71	1.07593	82.2	1426.93	1425.95	1.17294	87.2	1461.05	1460.07	1.27404
77.3	1394.35	1393.36	1.07784	82.3	1427.61	1426.62	1.17492	87.3	1461.74	1460.76	1.27610
77.4	1395.01	1394.02	1.07974	82.4	1428.28	1427.30	1.17690	87.4	1462.44	1461.45	1.27817
77.5	1395.67	1394.68	1.08164	82.5	1428.96	1427.97	1.17889	87.5	1463.13	1462.15	1.28024
77.6	1396.32	1395.33	1.08355	82.6	1429.63	1428.65	1.18088	87.6	1463.82	1462.84	1.28231
77.7	1396.98	1395.99	1.08545	82.7	1430.31	1429.32	1.18286	87.7	1464.51	1463.53	1.28438
77.8	1397.64	1396.65	1.08736	82.8	1430.98	1430.00	1.18485	87.8	1465.20	1464.22	1.28645
77.9	1398.30	1397.31	1.08927	82.9	1431.66	1430.67	1.18685	87.9	1465.90	1464.92	1.28852
78.0	1398.95	1397.96	1.09118	83.0	1432.34	1431.35	1.18884	88.0	1466.59	1465.61	1.29060
78.1	1399.61	1398.62	1.09310	83.1	1433.01	1432.03	1.19083	88.1	1467.28	1466.30	1.29268
78.2	1400.27	1399.28	1.09501	83.2	1433.69	1432.70	1.19283	88.2	1467.98	1467.00	1.29476
78.3	1400.93	1399.94	1.09693	83.3	1434.37	1433.38	1.19483	88.3	1468.67	1467.69	1.29684
78.4	1401.59	1400.60	1.09885	83.4	1435.04	1434.06	1.19683	88.4	1469.37	1468.39	1.29892
78.5	1402.25	1401.26	1.10077	83.5	1435.72	1434.74	1.19883	88.5	1470.06	1469.08	1.30100
78.6	1402.91	1401.92	1.10269	83.6	1436.40	1435.42	1.20083	88.6	1470.76	1469.78	1.30309
78.7	1403.57	1402.58	1.10461	83.7	1437.08	1436.09	1.20284	88.7	1471.45	1470.47	1.30518
78.8	1404.23	1403.24	1.10654	83.8	1437.76	1436.77	1.20484	88.8	1472.15	1471.17	1.30727
78.9	1404.90	1403.91	1.10846	83.9	1438.44	1437.45	1.20685	88.9	1472.84	1471.86	1.30936
79.0	1405.56	1404.57	1.11039	84.0	1439.12	1438.13	1.20886	89.0	1473.54	1472.56	1.31145
79.1	1406.22	1405.23	1.11232	84.1	1439.80	1438.81	1.21087	89.1	1474.24	1473.26	1.31354
79.2	1406.88	1405.89	1.11425	84.2	1440.48	1439.49	1.21288	89.2	1474.93	1473.95	1.31564
79.3	1407.55	1406.56	1.11618	84.3	1441.16	1440.18	1.21490	89.3	1475.63	1474.65	1.31774
79.4	1408.21	1407.22	1.11812	84.4	1441.84	1440.86	1.21691	89.4	1476.33	1475.35	1.31984
79.5	1408.87	1407.88	1.12005	84.5	1442.52	1441.54	1.21893	89.5	1477.03	1476.05	1.32194
79.6	1409.54	1408.55	1.12199	84.6	1443.20	1442.22	1.22095	89.6	1477.73	1476.75	1.32404
79.7	1410.20	1409.21	1.12393	84.7	1443.89	1442.90	1.22297	89.7	1478.42	1477.45	1.32615
79.8	1410.87	1409.88	1.12587	84.8	1444.57	1443.59	1.22499	89.8	1479.12	1478.14	1.32825
79.9	1411.53	1410.54	1.12781	84.9	1445.25	1444.27	1.22702	89.9	1479.82	1478.84	1.33036

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Ethiopian Standards Agency

Organization and Objectives

The Ethiopian Standards Agency (ESA) is the national standards body of Ethiopia established in 2010 based on regulation No. 193/2010.ESA is established due to the restructuring of Quality and Standards Authority of Ethiopia (QSAE) which was established in 1970.

ESA's objectives are:-

- ❖ Develop Ethiopian standards and establish a system that enable to check weather goods and services are in compliance with the required standards,
- ❖ Facilitate the country's technology transfer through the use of standards,
- ❖ Develop national standards for local products and services so as to make them competitive in the international market.

Ethiopian Standards

The Ethiopian Standards are developed by national technical committees which are composed of different stakeholders consisting of educational Institutions, research institutes, government organizations, certification, inspection, and testing organizations, regulatory bodies, consumer association etc. The requirements and/ or recommendations contained in Ethiopian Standards are consensus based that reflects the interest of the TC representatives and also of comments received from the public and other sources. Ethiopian Standards are approved by the National Standardization Council and are kept under continuous review after publication and updated regularly to take account of latest scientific and technological changes.
Orders for all Ethiopian Standards, International Standard and ASTM standards, including electronic versions, should be addressed to the Documentation and Publication Team at the Head office and Branch (Liaisons) offices. A catalogue of Ethiopian Standards is also available freely and can be accessed in from our website.

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International Involvement

ESA, representing Ethiopia, is a member of the International Organization for Standardization (ISO), and Codex Alimentarius Commission (CODEX). It also maintains close working relations with the international Electro-technical Commission (IEC) and American Society for Testing and Materials (ASTM).It is a founding member of the African Regional Organization for standardization (ARSO).

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